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CONFERENCE ON REFRIGERATED CONTAINERS

February 1, 1973

U.S. DEPARTMENT OF COMMERCE
Maritime Administration

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U.S. DEPARTMENT OF COMMERCE
Frederick B. Dent, Secretary
MARITIME ADMINISTRATION
Robert J. Blackwell
Assistant Secretary
for Maritime Affairs
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THE SECRETARY OF COMMERCE
Washington, D.C. 20230

January 31, 1973

Honorable Robert J. Blackwell
Assistant Secretary for
Maritime Affairs
U. S. Department of Commerce
Washington, D. C. 20235

Dear Mr. Blackwell:

I was pleased to hear that the Maritime Administration will sponsor a conference on refrigerated containers for transporting perishable commodities in U. S. foreign trade on February 1, 1973. I would like to underscore the importance of the subject you will be considering at the conference - the expansion of export markets for American fresh produce.

As barriers to free trade disappear, it is in our national interest to seek to extend the overseas markets for our plentiful food production. Not only does this aid in creating a favorable balance of trade, but it also acts as a favorable stimulus to our national economy as a whole.

Please convey to the conference's participants my best wishes for a successful and productive meeting, whose results -- in terms of increased trade -- will benefit not only themselves, but the nation as a whole.

Sincerely,

Frederick B. Dent
Secretary of Commerce Designate

CONFERENCE OBJECTIVES

Robert J. Blackwell
Assistant Secretary of Commerce for Maritime Affairs

It is a great pleasure for me to welcome you here this morning.

As some of you are undoubtedly aware, those of us who work in Washington face a peculiar problem. We sometimes are not fully attuned to events, problems, and developments that the private sector considers of great importance.

I am glad to see, by your presence here, that we are on the same wave length. By taking the time and trouble to come here for this one-day conference, you have validated our basic supposition.

We believe, and you apparently agree, that an important market for American agricultural exporters and shipping lines — a market that you as businessmen and the nation as a whole urgently require — is going untapped.

The importance of this subject, in fact, was brought home last week with the announcement of the final U.S. foreign trade statistics for 1972.

For those of us directly concerned with restoring this nation's balance of trade — the news was indeed distressing. For the second year in a row, the United States ran a trade deficit, this one amounting to nearly $7 billion. This represents almost three times the deficit that was chalked up last year.

Beyond the numbers on paper, however, such a deficit constitutes a real problem for this country. A nation that cannot pay for its vital imports with its exports is draining hard currency from its domestic economy, sapping its strength and impeding its economic growth. As one of the world's leading trading nations and as a bulwark of the world's economic stability, the United States cannot tolerate such deficits.

An analysis of our trade statistics makes abundantly clear the importance of agricultural exports. Over the years, this sector has been one of the brightest, with the U.S. enjoying consistent surpluses.

But grain and similar bulk commodities have constituted the vast majority of these exports. For the most part, American producers have not been fully exploiting the overseas market for the fresh produce that Americans take so much for granted.

We at the Maritime Administration — although our focus is on shipping rather than trade — are convinced that this situation can be materially improved by using the latest in refrigerated shipping techniques, particularly the use of reefer containers.

Additionally, we believe that American shipping lines can assist produce exporters in capitalizing on this technique and penetrating new markets for their goods.

The United States, with 100 full containerships and 84 partial ones in operation and on order, has the largest and most versatile intermodal fleet in the world. American lines pioneered the concept of container transport, developing the systems expertise needed to maximize the fast and reliable delivery of cargoes anywhere in the world.

Our dedication to the intermodal transport of goods clearly shows in the fact that this country has committed about $7.5 billion to this concept — in terms of ships, land carriers, and port facilities. We as a nation are obviously in this business to stay.

And let none of us imagine for a moment that these markets for fresh produce are not there. The constantly rising standard of living throughout the world is lifting the population's eyes above the subsistence level. Every year, more and more people enjoy the freedom of seeking something better than mere survival; and, certainly, a wide variety of fresh produce is one of the first such desires.

More specifically, recent developments in the world point to new markets for American produce.

The recent three-year trade agreement reached by the U.S. and the Soviet Union unlocks vast export opportunities for American firms. I can see no reason why agricultural trade with the Soviet Union should be limited to grains. The possibility of exporting fresh produce should be fully explored.

The President's trip to China last year holds out the possibility that this large market will in the near future be opened to American goods, including fresh produce.

Finally, with peace established last week in Vietnam, that war-shattered area should now become more stable. With this new-found stability, Southeast Asia will become a growing export area for the United States, as it will for other countries.

Capitalizing on these new markets, as well as expanding existing ones around the world, will not be child's play. Very real hurdles, in terms of equipment and service, remain to be overcome.

The interests represented here today are quite diverse. Shippers are primarily interested in getting their produce to markets as rapidly and economically as possible. Carriers are concerned with maximizing the return on the investment required to move reefer containers. And manufacturers are faced with the problem of providing economical, reliable containers and refrigeration systems that will meet the needs of both groups.

The object of this conference should now be apparent: We seek to bring together shippers, shipping lines, and equipment manufacturers for a frank exchange of ideas and concerns. Our goal is to couple the competitive excellence of our fresh produce with the competitive excellence of our intermodal ocean carriers to create a potent force for entering and capturing markets abroad.

With this goal in mind, I believe that this conference will prove successful in forging a new and productive alliance between produce shippers, U.S.-flag steamship lines, and American equipment makers — one that will benefit each of the firms you represent and the American economy as a whole.

Thank you.

PRESENT CONDITIONS-CARRIER EXPERIENCE

James L. Clark, Jr.
General Manager, Special Commodities Service
SEA-LAND SERVICE, INC.

As indicated in the program for this conference, my presentation is to be covering the carriers' experience in the refrigerated container field as it relates to the movement of perishable commodities and the present conditions surrounding this area.

In order to meaningfully relate to you where we stand today and what the future has, in the carriers' eyes, in store for us, I feel we must go back a few years, relate past experiences and then discuss the present and the future.

In fact, there have been, to date, three distinct phases of problem areas and accomplishments during the past 16 to 18 years since the advent of containerized shipment of perishable commodities. They all have to do with increased geographical services offered by the container operators and subsequent increased transit times.

<u>Phase 1</u> - (1958/60 to 1963)

During the period from 1958/60 to 1963, ocean transit times for the movement of perishable commodities by container very seldom exceeded 5 to 7 days. Similar transit times had been experienced domestically by motor and rail carriers for a number of years prior to that so it was only right to consider that road-type mechanical refrigeration equipment would be sufficient. Therefore, those of us carriers that were in the business during those years proceeded to buy typical highway transport refrigeration equipment with minor exterior modifications to combat the corrosive action of salt spray. By the time the refrigeration units were 2 to 3 years old, it was pretty evident that the corrosion problem was not only an exterior one but also reached into the component interior parts of the units themselves. (It didn't take a mechanical engineer to come up with this conclusion either, for the units were literally falling apart.) Failures were numerous and maintenance costs were astronomical. It was evident that a completely marine-type refrigeration unit had to be designed and built from the ground up.

Phase 2 - (1963-1966)

By mid-1963, the first of the truly marine built refrigeration units were in existence and during this period all of the older units in our fleet were phased out and replaced by the newly designed refrigeration unit. It was also during this period that inroads were made by the manufacturers in improvements in insulating materials and we went from the old fiberglass insulated plywood walled containers to the polyurethane foamed in-place insulated, fiberglass walled containers that are still in use today. Transit times during this period increased up to 12 to 14 days. However, the more reliable refrigeration units and the better insulated containers allowed for satisfactory outturn of the commodities handled with few failures.

Phase 3 - (1966/67 to the present)

It was at the beginning of this period in time that the true "container revolution" broke loose. Scheduled container service was offered between the United States and both Europe on the one hand, and the Far East on the other (of course, today we have container operations linking most of the countries of the world). Transit times were drastically increased and it was (and is) not uncommon to see perishable commodities moving on ocean voyages exceeding 30 days. Again, we were faced with a whole new list of major challenges in the containerized transport of perishable commodities. Excessive component failures in the refrigeration units themselves reared their ugly heads again and for other than freeze and hardy chill commodities, we for the first time found that the heat buildup in sensitive fruits and vegetables was such that our air circulation was not giving us sufficient product management for the lengthy transit times involved. Consequently, product temperature differentials within a load on some of the very lengthy transits would range excessively to a point where we were not really doing the job we felt our customers deserved.

In the area of attacking these problems, I will have to talk in terms of Sea-Land's programs as I can't professionally speak for the rest of the industry. We set about to accomplish our goals in the following manner:

As most of us at Sea-Land were basically only experienced in the movement of perishable commodities and the technical aspects of the equipment with which we had to work at that time, we could see that a considerable amount of additional research and development would be required in a short period to meet our objectives.

Therefore, in early 1968, we established a research and development department as a part of our Engineering Department and one of their major goals was to see to it that we continued to keep up with the needs in this area. Work was immediately begun with the transportation research and facilities group of the USDA and the manufacturers of refrigerated containers. In fact, the Springer Institute in Holland was used to develop sufficient data in an attempt to correct problem areas.

After preliminary data was compiled, two objectives were stressed: Fail safe operation and improved performance over longer routes.

In the area of accomplishments through R&D efforts during the past four years and at an expenditure approaching $500,000 on R&D strictly relating to the refrigeration unit itself, following are some examples:

A. Improvements in the existing units through retrofit programs:

   1. The development of an all electronic thermostat which has given increased reliability, less maintenance and more accurate temperature control in the load.

   2. The control system itself. Due to the fact that there are a large number of contracters and relays in the control circuit, this has been one of the areas which in the past has caused maintenance problems for all carriers. A removable electrical tray was developed so that if anything does go wrong in this area the whole refrigeration unit can be put back into service immediately by substituting another tray.

   3. Control circuits have been improved to such a degree that the failures presently experienced in the new system are approximately 1/5 of the failures that were experienced in the past.

4. Another major problem area was clutch failure. Through working with refrigeration unit manufacturers and individual vendors of this particular component part, considerable improvement has been able to be made.

5. Improved defrosting capabilities is another example of a major accomplishment through R&D efforts and is particularly important on fresh fruits and vegetables.

B. Development of a "New Generation Refrigeration Unit":

A new generation of refrigeration unit is now appearing which, in addition to incorporating capacity modulation and constant air flow (with or without refrigeration), promises to give still more increased reliability of components. Each component has been thoroughly tested, evaluated and chosen to fulfill the particular function with long mean time between failure prior to its acceptance.

I believe this pretty well brings us up to date on equipment capabilities.

I would now like to briefly discuss three problem areas with which carriers and exporters or potential exporters are still faced today:

1. Air Circulation - This to the carrier is the biggest problem area yet to be corrected in the line of improved temperature management of cargo in transit. Pet theories abound, glorious reports are written which say that one system or another is better but no numbers or data are published which indicate how much better and under what conditions.

   I cite for example the omnifarious USDA reverse air flow container about which much has been said and sold, however, on which nothing has been published in the line of meaningful data.

   In fact, it is my considered opinion that rather than spending years of time and efforts in coming up with what might be considered by some a panacea for all of our refrigerated ills, we had better fall back, regroup and consider the facts:

A. There are presently some 15,000 refrigerated containers in use by U.S. flag carriers alone. You can probably double that number when you take into consideration the foreign flag operators. These units for the most part have been purchased in the last 3 to 4 years and their useful life is 7 to 10 years.

B. These refrigerated containers are not going to just disappear and I feel we had better all consider (including the USDA) the fact that our major efforts should be aimed in the direction of coming up with improvements, particularly in air circulation, that can be installed through retrofit programs in existing refrigerated containers.

2. As we all know, the carrier can only be responsible for the protection of these perishable commodities during that portion of the time they are in his possession. There are several other factors that must very well be considered as basic contributors to good or poor outturn over which the carrier has little or no control. They are product quality, packaging, pre-cooling and loading practices:

A. Product Quality

In this area, I feel it is mandatory if we are to continue to make a name for ourselves in the export market that nothing but the finest grade of product is considered to be shipped. I can cite many instances in the past, as well as the present, where we are receiving produce for overseas shipment that is actually garbage before it is shipped. I feel a great deal of emphasis has to be placed in this important area, for no matter how meticulously the cargo is handled throughout its transit if it is poor quality to begin with it can only be poor quality at outturn.

B. Packaging

A considerable amount of research and development has been recently going on in this area, and I can say that much improvement has already been made. We must continue, however, to think in terms of the package facilitating temperature management through proper air circulation, as well as protecting the product itself from injury, either by bruising or compression, under severe stacking conditions. This is even more important when you consider the rolling and pitching that a refrigerated container is subjected to at sea. To save 15 to 20 cents per package and outturn inferior product to a customer in my mind is false economy.

C. Pre-cooling of perishables prior to loading

This is a very important problem area, for a refrigerated trailer or container must be considered the same as a cold storage warehouse. It is not designed to be a pre-cooling chamber. Perishable commodities should be pre-cooled down to carrying temperature before they are loaded into a container. One of the most common problems that occurs if this practice is not followed is that in an attempt to pull the field heat out of the product, the refrigeration unit will actually chill or freeze some of the cargo - particularly around the outside perimeter of the load. The USDA and most of the carriers have been preaching this gospel since the beginning of time and I feel considerable progress has been made through our combined efforts. The problem, however, still, all too frequently exists.

D. Loading of perishable cargo into the refrigerated container.

As you are probably well aware, many perishable commodities such as frozen products should be loaded in one solid mass, only leaving room for air to circulate around the outer perimeter of the entire load. In fact, most sensitive commodities

such as fresh fruits and vegetables can be loaded in this manner if transit times of a couple of days are involved. However, when loading perishable commodities for export shipment that generate heat as a matter of their ripening processes, maximum attention has to be given to the loading patterns. Utopia, of course, would be to load these commodities in a manner whereby the circulating air would surround each piece of fruit or vegetable. This, however, is not possible, but air flow loading of the packages themselves surely is and must be practiced.

3. Last but not least is transit time. The use of modern, fast containerships greatly reduce the sea leg duration consequently the time/exposure of risk of breakdown is proportionately reduced. Sea-Land's new SL-7 ships will have a speed of 33 knots. With this kind of speed a transatlantic crossing takes 4 to 5 days and a transpacific crossing takes 5 to 6 days.

In conclusion, I would like to assure you that Sea-Land and all our marine carrier colleagues are anxious to provide increased service to the perishable food shippers.

PRESENT CONDITIONS - SHIPPER EXPERIENCE

Bernard Mayrsohn
Executive Vice-President
PREVOR-MAYRSOHN INTERNATIONAL, INC.

As a shipper of fresh fruits and produce to all overseas markets, I am gratified to participate in this conference which is addressed to extending and introducing new markets for the items we ship. I will discuss today our past experiences, and what we are doing now, and what we hope to do in the future to expand our industry.

Before containerization, we shipped our fresh fruits and produce in break bulk, either in or outside of the ship's refrigeration. Shipments were from only a few of the major U.S. ports. Due to heavy spoilage, we were forced to limit our exports to the hardware items, such as apples, potatoes, onions and citrus, and at times pears, and some grapes. This spoilage was due to extra pier handling, loading and unloading at piers here and abroad, also change in the temperatures of the product when brought to piers, unloaded, and waiting its turn to go into steamship coolers. Careless handling resulted in many broken cases and shortages. At every pier spilled apples, or onions, or oranges could be seen at shipping time. Many felt this was done deliberately to make certain that every dock worker had some fruit to take home.

The result of these break bulk shipments were obvious. The risks were great, as were the losses. Shippers demanded letters of credit or prepayment from even the best buyers. These prudent buyers minimized their needs and their resulting orders. Needless to say all these factors discouraged the exports of fresh fruits and vegetables.

The early containers were an immediate remedy to many of our problems. Pilferage and broken packages were eliminated, but we still had some internal breakage in the containers.

While we had the advantage of loading ourselves, we had inadequate tailgate facilities. Also, we were inexperienced in proper loading.

The early refrigerating equipment was poor and often did not function properly during the voyage.

Poor air circulation did not evenly distribute the little cold air that was provided.

Insulation was not good enough, and we noticed differences inside when it was hot, or very cold outside.

Also, those new containers did not usually refrigerate during the trucking from our stations to the piers. At times the pier's receiving clerks were slow in getting loads plugged to get refrigeration started. The number of container shipping ports were limited to a few major points in this country, and in the foreign ports. The great distances from most shipping points to loading stations at our markets, resulted in the same high inland freight charges as we had in the past.

The closeness of the ports is very important to us and we constantly ask steamship companies to open ports near our shipping points. We are always gratified to learn that new ports are available to us and we trust we can see this trend continue.

When we first had the early containers we had only few ports which encourage us to mix containers of several different fruits and produce that were compatable, because buyers were not ready to buy full loads, and our terminal markets like Hunts Point in New York enabled us to make these compatable mixtures.

Also our foreign buyers requested that we stack the containers at our facilities so they could off load at several places upon arrival, minimizing their handling, and using the containers for trucking and cold storage in the tropics, and in Scandinavia as trucking and heating during the winter months.

Mixing loads even today continues to be important to our foreign buyers.

To summarize, these early containers, while very helpful and promising, still had their problems and did not reduce our costs.

During the past ten years, however, improvements have been made gradually. Many refrigeration experts have worked on improving quality and performance, and are still working intensely on air circulation, the value and perfection of controlled atmosphere, and humidity control.

We have developed improvements in arranging and stacking inside containers to maximize air circulation. At the same time we brace the load to avoid shifting en route. This tends to refrigerate the load evently throughout the container. Our tailgage facilities are now available to load quickly and economically.

Full container loads of a single item promise to lead us into greater volume shipments. The following developments have enabled us to develop this promising trend.

1) More container ports near our shipping sections, which reduces inland freight charges and time, resulting in faster arrivals to ports with better quality and cheaper costs.

2) Uniform loading of a single product, affords the optimum temperature.

3) We can give the item what it needs, icing for the leafy products or gas for the items that benefit a product such as tomatoes, which need ripening, or controlled atmosphere which would tend to put the product to sleep and arrive in a better condition.

In the fresh fruit and produce business no two seasons are alike. Factors of weather, labor, size and quality of crops, sizes of products produced, various currency valuations, and restrictions of imports imposed by foreign governments either by higher duties, or actual limitation of import amounts, or arrival or termination dates, together with preferred treatments for Common Market or Commonwealth tend to influence our exports.

These variable factors, including political conditions, recall to mind the situation several years ago when there was a civil war in Cyprus. This affected the normal shipping of spring carrots to the U.K. and Europe. We received a call from London asking if there were any carrots in the U.S. It happened at that time that Texas had such a bumper crop of excellent quality carrots they could not sell all they had. Many were left unharvested and many were consigned unsold to the New York market. We quickly satisfied the U.K. and European demand, and at the same time satisfied the Texas growers. We also established the market for Texas carrots on the European markets we all have enjoyed since.

As we know no two seasons are ever alike. We must be alert to all possibilities. You all know that almost every day we read in the papers of some major weather problem somewhere in the world, or some labor trouble or some political mess somewhere. This week we learned that heavy snows and cold temperatures damaged seriously the early spring crop of citrus and many vegetables in eastern Mediterrean areas. This will affect our shipments to their markets in Europe. We in New York are in the center of this activity worldwide, as now so many items from the western hemisphere end up in Europe. Almost all important foreign buyers now check New York for our offers before deciding where to place their orders.

In this country I believe we have more modern mechanized harvesting, grading, packing and shipping facilities than do most producing countries of the world. With our mass production and efficiencies we can bring our products into foreign markets cheaper in many cases than locally grown items shipped into their own major markets.

This is especially true when we are at our optimum stages. Usually this is when the quality and the condition of our product is at its best. Often during these heavy production peaks, prices are generally so low that growers do not get back their harvest costs. It is at those times particularly that we have to be in foreign markets even in the face of their domestic production.

We in the U.S. generally have a longer growing period than most other producing areas. This enables us to purchase more modern and expensive grading and packing equipment resulting in greater cost effectiveness. We in the U.S. can be proud of our production results; we spend less of our disposable dollar on food then does the European housewife, while at the same time we eat better and have a better selection available to us.

However, we know that a greater proportion of the European food bill goes into fresh fruits and produce than into the American food bill. It seems the European and Japanese like fresh produce and fruits better than we, for they buy more and will spend more for the fresh product than we will.

Not only can we find new markets and find new dollars but we can aid the producing sections of our country by disposing of the surplus crops at peak production. This would enable our growers to utilize their facilities and labor better and market their entire crop, not just a part of it.

In our industry, we are constantly looking for new possibilities and I can say hardly a week goes by that some foreign buyer does not ask for price or supply information. Their interest can range from cherry tomatoes to red peppers, from strawberries to fresh limes, the whole spectrum of produce. As an exporter and importer we know our future profit depends on the price and the quality of the produce we deal in.

To further along our competitive position and expand our trade by improving our quality and reducing our prices, we could use the following developments:

1) More and faster container ships.

2) Departures from more U.S. ports, hopefully nearer to producing areas.

3) More foreign ports of call so we can increase our markets.

4) More and improved steamship refrigerated equipment and containers available at all shipping stations. This is most important as we need experienced handlers and loaders at the packing stations to properly airstack and load. Airstack means providing passages within the container to get the proper air distribution.

   Having the containers at the packing houses keeps the product under constant refrigeration from precooling chambers into precooled containers.

5) U.S.D.A. inspections made at the shipping station when loading the container before doors are closed, so we know exactly what's inside, and our recording machines to record temperatures en route.

6) We need some governmental help in protecting us against unfair foreign government restrictions.

7) The lower dollar value relative to the foreign currencies has helped, and some governmental help can be given the exporter to enable our sales to continue along these lines.

8) Finally we could use our government's help in being introduced to the corresponding buyers for the governments of Eastern Europe, Russia and perhaps China.

We know how to contact any buyer in the free world and are alert and active to sell, and we encourage sales to any buyer that so much as raises his head to ask for an offer.

In the last ten years, in fact really since we have had the opportunity to use containers in our exports, our trade has expanded enormously.

I know from personal experience we have had a steady increase in the exports of many different items to many different countries. This increase is continuing with even greater intensity this year, and our firm is seeing this increase this season.

We will continue to do whatever we can to enhance this business, and aid any program by the steamship companies, the Department of Agriculture, or our Department of Commerce.

To close, I would especially like to commend the Department of Commerce and the foreign service of the U.S.D.A. for this conference. We trust it will produce a better climate to dramatically expand our sales of fresh fruits and produce.

Thank you.

REFRIGERATED CONTAINER EQUIPMENT
STANDARD SPECIFICATIONS FOR REFRIGERATED CONTAINERS

Vincent G. Grey
Chief, Equipment and Systems Design Branch
Office of Ports and Intermodal Systems
MARITIME ADMINISTRATION

In this AsTec Conference we want to consider the wider utilization of refrigerated containers in exporting perishable commodities. Given the situation that the marketing climate and freight rates are favorable for exporting perishables, the success or failure of the venture revolves mainly around the hardware, that is, the ability of the container to preserve the commodity in transit and to deliver it in good condition. To succeed we need reliable performance of the refrigerated containers and we need to know their limitations. We need design specifications to guide the original buyer, and test methods to determine whether the specifications have been met. Specifications would also be advantageous to use as a gauge for determining the true condition of older containers so that the owner can judge whether they should be continued in service, repaired, converted, or discarded. I'm pleased to report that these needs for a standard refrigerated container are about to be met.

On January 12, just $2\frac{1}{2}$ weeks ago, the final editorial review was given to a proposed standard specification that has been seven years in the making. Its development was carried on within the American National Standards Institute Committee MH5, Standardization of Cargo Containers, and is closely related to the work that has gone on in a corresponding committee in the International Organization for Standardization, the world-recognized forum for establishing international standards. In my printed paper I will cover how this draft was developed, what were the principal influences in its preparation, and how the ISO and ANSI Committees were composed. *But for now suffice it to say that the proposed standard has had the input of shippers, carriers, manufacturers, government agencies, professional societies, and the like.

The specification is entitled Draft American National Standard Requirements for Thermal Containers, and when it is given final approval by ANSI, it will bear the designator MH5.1.2-1973. The term "Thermal Containers", by the way, covers all types of containers where the rate of heat transfer is controlled, that is, the term includes containers that are refrigerated, heated, or simply insulated. Of the refrigerated types, the Draft

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* See Addendum on page 26

Standard covers containers which are mechanically refrigerated, those refrigerated with an expendable refrigerant or those which utilize the ship's refrigeration capability and attach clip-on units for the overland haul.

Thermal Containers must be compatible with other types of containers within the container system. They must display the same structural capability as closed vans since they, too, will be required to withstand the forces imposed during stacking, racking, lifting from the bottom or from the top, etc. Reefers must meet all of the prescribed tests for end-wall strength, side-wall strength, roof and floor strength, and they are permitted the same optional features as fork-lift pockets, or the tunnel in the container base necessary to accommodate a goose-neck trailer chassis. However, a refrigerated container additionally needs to have something said about air leakage, about structural tests for meat rails, and other design considerations exclusive with these special containers. The standard load of hanging meat to be supported by the meat- rails has been established at 1,000 lbs. per foot of length of usable cargo space. A forty-foot container would have approximately 36,000 lbs. of meat supported by hooks with 20,000 lbs. on the floor.

Naturally, the roof must be designed to withstand more than just the hanging weight of the meat. Otherwise, as soon as the container receives a jolt in landing the container on a chassis, the roof bows or rails would fail. It is therefore necessary to apply a supplemental operational factor to account for such inertial effects. This combined force is taken to be twice the static load and thus becomes the test-load for the meat-rail type of refrigerated containers.

In the standard, redundancy of tests is avoided. For example, only one side wall needs to be tested for strength so long as both sides are identical. Where there is a side door, optionally installed in one side, it is necessary that both sides be tested.

An area of unique concern in thermal containers is air-tightness. The standard specification permits the escape of a certain volume of air which varies according to the size of the container. If the basic allowance is exceeded, a correction factor must be applied to the heat-transfer rate determined during the thermal tests because what you have, in effect, is a condition of blowing out cold air and pulling in warm air, placing a significant additional burden on the refrigeration unit. There is also a maximum permissible figure for air leakage beyond which the whole approach of determining the thermal conductivity of the container under test is no longer valid.

A water-tightness test is also required but is not essentially different from that required for close vans except that all vents, drains, and nosemount seams are carefully tested as well as the door seals.

The next area of concern in thermal containers is its capability to resist the transmission of heat through the container construction. The Draft Standard spells out the manner of conducting the thermal tests, the location of the instruments, conditions of testing, accuracy of instruments, duration of test, frequency of data recordings, etc. It may be of interest to note that the MH5 Standard employs the technique of heating the interior of the container above its exterior. Within the ISO two methods are equally recognized, interior cooling and interior heating. In the U.S.A. the interior heating method was selected because it is more easily conducted, needs no elaborate test chamber or sophisticated equipment, it is cheaper and requires less-skilled technicians. The development of these tests has been closely related to the research and testing programs conducted by the container manufacturers under the auspices of the Truck Trailer Manufacturers Association. Slight variations in test conditions do exist between the TTMA work and those proposed in the new MH5 Standard but the results have a direct correlation with each other and can be transposed from one to the other.

Of special interest to shippers and carriers is the new rating plate that can be mounted on containers by the manufacturer to show the heat transmission rate of a new container. The manufacturers today are ready to embark on this program and will install a rating plate if called upon to do so by the purchaser.

With regard to physical dimensions, the external overall dimensions will still comply with those established for closed vans. The interior width has been established as 88 inches minimum as opposed to 92 inches for a non-insulated dry van container.

No minimal internal height or length was set because it would tend to limit the designer's freedom to install ductwork in the container overhead and nose. The door opening height was established as 84 inches minimum and the door width would be full opening, that is, 88 inches minimum.

The electrical requirements for the container power are already covered in the American National Standard Basic Requirements MH5.1-1971. In fact, many of the details of construction common to all types of standard containers such as overall manufacturing tolerances, weight-ratings of

the containers, corner fitting configuration and other details are given in the basic document. If you marry the general spec to this new one I have just described, a total package specification for a standard refrigerated container will result.

The work of the MH5 Thermal Container Committee continues. At the January 12th meeting it was agreed to consider such new matters as these:

a) Should a recorder be prescribed for a standard reefer container? If so, how should it be specified?

b) What calibration technique should be employed for the temperature indicating devices and pressure gauges?

c) Should there be an automatic defrost cycle and should it have a manual override?

d) Should the thermostatic sensor be located in the intake airstream or in the return duct?

e) What kind of alarm or warning light should be used? If either, what conditions should be monitored?

f) Where cooling and heating are both provided in a reefer box, should the control be automatic or should a selection switch be provided?

g) In a defrost cycle, should water be drained into or outside the box?

h) If a diesel generator set is used, should the exhaust pipe be located in a standard position? Should it be aimed in a fixed direction?

i) Should thermocouple probes be installed that permit remote thermometer surveillance?

j) Should there be a standard nozzle opening at the door frame for introducing fumigants, inert gas blankets, and direct expansion refrigerants for rapid pull-down of the interior temperature?

You can see much planning goes into the making of one of these containers. These items are operator-oriented problems, yet they pertain to features that can be the root of equipment failures if some attention is not given them.

It is my conviction that the Standard Requirements for Thermal Containers will become, before this year is out, the basic purchase specification within the industry. Reefer container purchasers should insist on the rating plate so that a plateau of quality will be established within the industry. For this reason, the rating plate will evolve as the convenient means of measuring the thermal capability in actual service. Regrettably it is not possible to establish tests for the performance of the container with its cargo in place. Obviously the performance of the container reefer-unit, and its air distribution effectiveness will be dependent upon stowage patterns, ductwork configurations, nature of commodity, climactic conditions and others.

The MH5 Standard does not deal with the sampling technique that should be followed in container purchasing. Nevertheless, it seems advisable that attention be given to the number of containers that should be tested for quality control. If only the first container is to be tested as a prototype for an entire production run, the purchaser must guard against unusual attentiveness and special treatment being rendered to that one container by the manufacturer. Random sampling and testing during the production run has been suggested as a more realistic indication of construction quality.

These standard specifications coupled with selection of reputable and proven manufacturers will give the carrier, shipper, and leasing companies the assurance of reliable performance in transporting perishables.

The standard specifications issued by ANSI certainly are not the total answer to a program for trade expansion of perishable food products. Yet the hardware aspect is a critical factor and is a critical factor and its dependability in service to maintain set conditions within the box is only now beginning to reach acceptable levels. We want to encourage you all to implement these new specifications and advise us in MarAd or in the Department of Agriculture whether you discover any shortcomings. Through the cooperative efforts of all concerned, we can embark on a new trade expansion program where we will all benefit.

Victor Hugo wrote "There is one thing stronger than all the armies of the world and that is an idea whose time has come."

For many of us who have been close to the container evolution, there are all the signs that we are on the threshold of the Era of the Reefer Container. Truly it is an idea whose time has come. What role you are to play in the drama is for you to decide.

Thank you.

Addendum

The American National Standards Institute has a twofold purpose: as the national standards body of the USA it approves standards as "American National Standards", and, as the USA member-body of the International Organization for Standardization (ISO), it serves as the channel for USA participation in ISO activities. In the former capacity, it provides the administrative, judicial machinery to determine whether a national consensus exists in support of proposed standards, and upon finding evidence of such consensus, to declare their acceptance. In the latter capacity, it provides the machinery to carry on technical international standardization programs, appoint delegates to ISO international meetings, process proposed international standards and furnishes the American representation on the Council, General Assembly and other administrative and supervisory bodies of ISO.

The standardization of intermodal freight containers on a national scale is entrusted to the ANSI material handling committee MH5. It is composed of some 75 American trade associations, technical societies, professional societies, government agencies, classification and inspection groups, and the like. Taken as a whole, they constitute the "national consensus" on technical, economic and regulatory aspects of containers. Naturally it would be impractical to have representation on MH5 from every American business firm and agency that had an interest in the subject of freight containers; the number would run into the scores of thousands. Instead, a representational system is used so that one individual may serve as spokesman for an entire industry-wide constituency. In that fasion, a true national consensus on containerization can be amassed and still keep the size of the committee manageable.

This MH5 committee not only is empowered to deal with domestic container matters but is charged likewise with conducting the USA's international container affairs in ISO. Within the ISO framework, intermodal freight containers are studied by Technical Committee 104, abbreviated ISO/TC 104. Presently, 40 countries are members of the committee and the preponderance of them are those nations active in intercontinental container transport. As a consequence of the November 1972 UN/IMCO Conference on International Container Traffic where the importance of TC 104's work was stressed, it is expected that many other countries shortly will seek membership in ISO/TC 104.

The United States has been a principal participant in the ISO work on Thermal Containers under TC 104. Because of this direct involvement, it was possible in the drafting of the proposed MH5 standard to utilize the best of the ISO work and add to it certain refinements and improvements that were prompted by the extensive we have gained here in the U.S. in the movement of refrigerated goods, or speaking more broadly, of temperature-controlled goods.

There have been four major influences on the MH5 draft standard:

a) the academic, polished professional input and original orientation of an MH5 committee led by C.W. Phillips of the National Bureau of Standards;

b) the complex, interdisciplinary input of the ISO international activity led by Bert Bodenheimer of Sea-Land Corp., who has served as leader of the USA delegation to ISO meetings in this specialty area;

c) the competitive, cost-conscious aspect of the refrigerated container manufacturers guided by John Storz of Great Dane Trailers, chairman of the Truck Trailer Manufacturers Association Refrigeration Subcommittee, and;

d) the pragmatic, utilitarian element personified by Captain Merle Allen of the Marine Container Equipment Certification Corp., the chairman of the MH5 Thermal Container Task Force.

These men and the groups over which they presided have since 1966 arduously hammered out the present "Draft American National Standard Requirements for Thermal Containers, MH5.1.2-1973". After the Draft receives final ANSI approval, it will be available from American National Standards Institute, 1430 Broadway, New York, New York, 10018. Telephone Mr. George Bowen (212) 866-1220.

REFRIGERATED CONTAINER EQUIPMENT-CONTAINER CONSTRUCTION

Clark E. Abbott
Vice President Containers
Fruehauf Corporation

Ladies and Gentlemen,

Ideally, the best method of transporting perishable commodities is in a "perfect vacuum".

However, the cost for producing containers with this "perfect insulation" is prohibitive. Even though research work is being accomplished in this area, so far no one has been able to produce such a unit which fits most pocketbooks. Nevertheless, it will eventually become commonplace.

Until this can be accomplished, we must go forth with what we have in todays' world. It must be practical and within the realm of our comptrollers.

Todays' refrigerated container has evolved from ice packed cartons hauled in the bowels of wooden ships, to a rather complex refrigeration system stored above and below decks of our modern, bulbous-bowed, turbine-driven cargo ships.

We build container shells from various materials:

(1) All Steel
(2) All Aluminum
(3) Aluminum and Steel composites
(4) F.R.P. - Fiberglass reinforced plywood
(5) Fiberglass Sandwich

These materials are used in various methods. The most common of these is the aluminum container with steel end frames. This container is constructed from basically the same material as a dry freight container. It has sidewalls, roof and front walls and rear doors. From here on, however, the refrigerated container differs

greatly from the dry freight unit. Instead of a regular laminated wood floor, screwed to the crossmembers, the floor section of a reefer container is built up over the crossmembers. First, we add a metal or plywood subfloor, then spacers - usually of wood, and finally the top floor, usually an aluminum DuctBoard or "T" - type extrusion. This top floor is either welded into one sheet or sealed, making the entire floor structure a fully waterproof surface. Depending upon the manufacturing process required, the "T" shapes may either be lengthwise or crosswise.

Drains placed in the four corners of the floor, or as required, have self-sealing sleeves at their lower ends. These devices keep heavy cold air from being lost from the container, yet release any water that accumulates in the drains.

What really makes a Refrigerated Container different, is the insulation. We've made significant strides in improving this medium, which evolved from sawdust, to cork, to kimsul, to steel wool, to fiberglass, to block foam, to medium density polyurethane foam, and finally to where we are today — the new lightweight, low density, foamed-in-place polyurethane foam insulation.

Today's new lightweight low density foam insulation is freon gas blown and utilizes a heated mold installation process. This insulation not only provides the most efficient insulation to date, but is extremely light in weight - 2.3 pounds per cubic foot.

This foam insulation is also resilient, tough and dimensionally stable. It will not shrink or swell during the life of the container. It is not attacked by fungus, rot, corrosion or vermin. It has an exceptionally low K factor, which with its efficiency in resisting moisture and air, permits lower temperatures to be maintained more easily and longer, with less thickness of insulation. This provides more cubic capacity, more room for payload, less demand on the refrigeration source and, most important, longer protection time for the cargo in the event of a breakdown of the refrigeration means.

Although this insulation appears to be a fine textured cellular structure, it is impregnable to the passage of air and water vapor. It consists of myriads of closed cells produced by a precisely controlled foaming process. Each cell encloses the entrapped freon

gas which inflated the cell when it was formed. Thus, the mass of insulation consists either of the solids of the polyurethane or the gas inside each enclosed cell. There are no voids for air to get through, for water to get in, or for heat to sneak through.

Polyurethane insulation also provides fire retardation properties, and other capabilities we have already touched on, but today take for granted. For instance, no one will argue the enormous weight savings over sawdust, and the impregnability to water absorption. Each of these items were, at one stage of the game, problems which had to be dealt with. For example, as recently as 1945, refrigerated trailers delivered with the insulating materials of the time, were known to have taken on weight year by year. There are cases where units gained 4,000 pounds in tare weight over a four year period. Think of the lost revenue as well as the tremendous extra work necessary to keep these cargoes at the desired temperatures.

Manufacturers in todays market have to produce units capable of transporting many varied products for unlimited distances. Our designs have to be capable of retaining varying temperatures to accommodate specific cargoes. Insulation wall thickness and type of refrigeration systems have to be given consideration to meet the requirements of the product hauled, within this varied outside temperature. Therefore, it is necessary to vary the thicknesses of insulation according to each specific haul, yet provide adequate insulative properties. In other words, it takes less insulation to transport ice cream from Mermansk to Maine, than it does from San Juan to Singapore.

At the same time, our designs must be compatible to the carriers' specified refrigeration unit. We must be adaptable to several types of nose mounted mechanical systems, liquid carbon dioxide systems, liquid nitrogen systems, etc.

Our refrigerated containers must also be sealed properly, if we are to retain optimum refrigeration. Refrigerated container linings, offered in plywood, fiberglass, reinforced plastic, stainless steel, etc., are sealed with a special silicone compound to make the interior air and water tight. Around the inside perimeter of the

insulated door, a special hollow vinyl or sponge gasket is fitted, preventing any air from entering the container. In addition, an outer seal of solid vinyl or rubber is placed on the outside perimeter of the doors. This second gasket prevents water from entering the space between the sill and inner gasket, and freezing the door shut. A condition which might disrupt the insulating effect of the vehicle.

Considerations to provide various options, as well as meet the various international standards, have also become an integral part of container manufacturing. Operators are offered bulkheads, so if they are utilizing nose mounted refrigeration units, they are given extra protection from shifting loads and also provided a means of returning circulated air to the condenser.

Rubberized cloth, vinyl, fiberglass-reinforced-plywood, or metal ducting is also a standard option employed by several container operators. These devices are used to direct the cooled air over the entire length of the container and work in conjunction with the "T"-type flooring to provide good movement of the cooled air around the cargo for maximum cooling efficiency. Additional air circulation devices include cross-vent holes in the "T"-type flooring and false wall lining.

Special vent doors, usually small in size, are sometimes also incorporated into refrigerated containers. These are especially useful when the operator utilizes these units for hauling produce. In this case, the containers may need changes of air.

Specialty cargo handling devices are also a part of the intrinsic design. Removeable meat rails, for instance, which give the operator the ability to transport handing meat, are one of these items. Properties to handle loads under partial vacuum must also be considered when containers are manufactured.

Because most container operations involve international trade, container manufacturers must design containers which meet various standards and customs regulations. In other words, we must meet International Standards Organization (I.S.O.) requirements, American National Standards Institute (A.N.S.I.) and Transport International Routier (T.I.R.) specifications. These organizations have set up to not only make sure the units will live up to certain requirements, but also preclude the possibility of any contraband being hidden or attached to the container. This is more complicated than meets the eye, because many refrigerated containers have duct work, bulkheads, vent doors, etc.

T.I.R. requirements indicate that all openings must be sealed in such a manner as to make it obvious if any of the aforementioned have been tampered with, when the container arrives at its destination.

Yes, containerization has grown immensely since the days of the Phoenicians. We've come a long way since we begain insulating vehicles with sawdust and refrigerating them with crushed ice and rock salt.

With all of this behind us, can the "perfect vacuum" container be far ahead? Thank you.

REFRIGERATED CONTAINER EQUIPMENT–REFRIGERATION UNIT CAPABILITY

Malchoff J. Davis
Transportation Engineering Manager
Carrier Transicold Company
A Division of Carrier Corporation

The United States Refrigeration Industry produces a wide variety of container refrigeration units to meet your requirements for the successful transportation of perishable products. Basically, two unit types are in use: (1) nitrogen systems using liquified nitrogen stored in a tank with spray headers to distribute low temperature gas into the container; and (2) mechanical refrigeration systems operating on the same principle as your home refrigerator.

The nitrogen system has generally been applied in special application and to date is in limited use; whereas, the mechanical refrigeration units are the generally accepted standard with thousands of units currently in service. While the nitrogen systems should not be disregarded in consideration of your particular needs, their successful application does require a closer study than mechanical units. My discussion is related soley to mechanical refrigeration.

A wide variety of units are available to you. This series of slides show the general types.

1. Direct drive with a propane or diesel engine direct driving the compressor and belt driving the condenser and evaporator fans. Electric stand-by capability is also provided through a clutch and electric motor.

2. All electric unit replacing the end wall of the container with power being supplied by dock or ships power supply; or for over-the-road movement, a separate diesel generator set can be mounted on the trailer chassis.

3. One type of diesel generator set powered by a four cylinder diesel engine for mounting underneath the chassis.

4. All electric unit with an intergal, but removeable, diesel generator set. Power can also be supplied from a remote source. Incidentally, this is an actual working unit being used by the USDA in their testing and evaluation program for refrigerated containers.

5. Direct drive - clip-on unit specifically designed for off-ship transportation of the ISO, 1C thermal container with air apertures in the end wall.

6. The unit is powered by a two-cylinder diesel engine coupled to the compressor with belt drive to the condenser and evaporator fans.

7. A liquid nitrogen unit.

The mechanical units are further categorized by the direction of air flow from the cooling coil.

1. Up-flow with air leaving at the top of the unit and return air entering the bottom at the floor level of the container.

2. Down-flow with leaving air discharging into T-bar container floor and return air entering at the ceiling level.

Both types of air flow have been successfully applied in service, with the choice depending on such factors as customer preference, type of product, container designs, and planned loading pattern.

Some of the units shown can be obtained with either type of air flow.

Also, these types are available in the capacities required for either 20 ft. or 40 ft. containers.

A few pros and cons for the various types are:

Pro	Con
Belt Drive from Engine with Built In Option of Electric Standby	
1. Option to run on own or external electric power supply.	1. Belt drive is not as reliable as direct drive.
2. Low first cost when compared to all electric unit with generator set.	2. Weight penalty because engine is always carried aboard ship.
	3. Maintenance cost high compared to all electric system.

Pro	Con
All Electric Front Wall Mount	
1. Easily serviced	1. Must be positioned where electric power supply is available.
2. Simplicity of design (Heating, Defrost, Cooling)	
3. Highest reliability due to its simplicity.	
4. Installed system removes lowest usable cargo cube	
5. Lowest capital investment of permanent installed systems	
6. Low operating cost	
All Electric with Demountable Generator	
1. Easily serviced	1. Removes large amount of usable cargo cube
2. Can utilize any chassis and can travel COFC	2. Depending on ratio of generator sets to complete, first cost can be relatively high.
3. High reliability	
4. Interchangeability of power pak	3. With a complete system the weight of an empty container is relatively high.
5. Option available to operate on own or external power supply	
Clip-On Style Direct Drive	
1. No loss of usable cargo cube	1. Special ships system
2. Easy change out of units	2. Refrigeration units must be mounted and demounted.
3. Lowest first cost depending on ratio of containers to refrigeration systems.	3. Maintenance cost high compared to all electric system.

The final selection must consider the total transportation cycle from originating source to final user.

Incorporated into these units are the capabilities for cooling, heating, air circulation, changing container air, and controlling the performance to successfully transport frozen or chilled loads in ambients ranging from 100°F to -40°F.

The designs have evolved from working with many customers and are a balance of technical and economic considerations; such as, capacity, air flow quantity, first cost, reliability, loss of container cube, container design, and power requirements.

A primary concern to both manufacturer and user in this evolution has been to obtain enough capacity for frozen loads and yet have the control necessary to transport chilled loads without excessive dehydration and avoiding freeze damage.

Capacity is the measure of the quantity of air being circulated through the evaporator coil and the difference in temperature or ΔT of the air leaving and entering the coil and varies both with ambient temperature and the temperature inside the container. In order to transport chilled products without excessive dehydration, the ΔT must be kept as low and as consistent as possible after the desired holding temperature is reached.

It is a function of the refrigeration unit that as the box temperature falls, the capacity decreases so that as the holding temperature is reached, the capacity more nearly balances the load. On a typical refrigeration unit for a 40 ft. container at 100°F ambient, the ΔT of the evaporator will decrease from approximately 15°F at a 70°F box temperature to 11°F at 35°F. This, coupled with on-off control of the compressor at holding temperature, provides adequate control for many products. During the compressor off cycle, the air circulating fans continue running to maintain uniform product temperature and prevent "hot spots."

This type of control is not adequate for sensitive chilled loads such as lettuce, berries, etc. Here, closely controlled temperatures and minimum dehydration are a must if a quality product is to be delivered. This is achieved by artificially reducing the refrigeration effect. Two methods are currently used: (1) compressor cylinder unloading which reduces the output of the compressor; or (2) hot gas by-pass which increases the temperature of the refrigerant media supplied to the evaporator.

Both methods work satisfactorily with cylinder unloading having the additional advantage of reducing power requirements.

With capacity control, the difference between leaving and return air can be reduced to approximately 6°F at a 35° box temperature.

Transporting frozen products requires less sophistication. Enough capacity to maintain the desired temperature must be provided, but simple on-off control of the compressor is adequate for all types of products.

In order to effectively utilize the capabilities of the refrigeration units, the internal temperature of the container must be sensed and signals provided to trigger the various modes of operation. Briefly, the device employed is a thermostat with multiple switching actions initiated in response to temperature change sensed at the return air inlet of the refrigeration unit.

Assuming a 35°F set point, a typical control sequence with container temperature decreasing from 70°F will be:

at 70°F cylinders loaded the ΔT of evaporator air is 15°F
at 38°F Δ T of evaporator air is 12°F
at 37°F cylinders unload Δ T of evaporator air is 6°F
at 35°F compressor is shut down - evaporator fan continues to run

These are approximate temperatures based on a fixed ambient temperature and will change to some degree within service variables.

If ambient conditions are low enough, the container temperature will continue to fall.

At 33°F the heating elements are energized.

As the temperature rises, heating is discontinued at 34°F and the other functions occur in reverse order at about the same temperature as stated earlier.

On frozen loads, setting the thermostat below 20°F locks out the heating cycle.

Regardless of how good the refrigeration control may be, delivery of a good product requires a carefully planned marriage between the refrigeration unit, the container, and the product loading pattern. Must items are:

1. Container must have provision to distribute the air leaving the evaporator throughout the container and avoid blasting directly on products near the unit.

2. Loading patterns must be such that air flow reaches all the products as uniformily as possible.

3. Loading patterns must be maintained during transit.

4. Containers must be maintained to assure minimum air and heat leakage.

5. Refrigeration units must be maintained in good working order, including calibration of thermostats.

As in life, the success of the refrigeration unit-container marriage depends on what is put into it. The product delivered at the end can be no better than that loaded. All perishables are sensitive to temperature, and field or body heat must be rapidly removed to preserve quality. The refrigerated container is not designed to accomplish this. Therefore, most perishables must be precooled and loaded near the desired transportation temperature.

A rather complicated subject has been covered in a few minutes. Although you may not remember details, there are two points that really summarize what I hope you will remember.

1. Container refrigeration equipment is available to successfully transport all types of perishable products.

2. The equipment manufacturers are ready, willing, and able to work with you on your specific needs.

REFRIGERATED CONTAINER EQUIPMENT-INSTRUMENTATION CAPABILITY

F. Abbott Chapman
Chief Engineer
The Partlow Corporation

Gentlemen, as you know, the temperature control or thermostat is the nerve center or brain of any mobile refrigeration system. It calls the signals; it tells the refrigeration unit whether it should be in heating or in cooling. Just how well do temperature controls perform this duty, and just what can you expect from todays temperature controls?

I am by far the most familiar with my own company's products and am forced to draw on their design and field experience. There is some justification, as we do have a very large number of units functioning in the field today.

First, I want to consider some of the design parameters for a temperature control in the container field. It must be rugged. It is going to be subject to many shocks, whether on shipboard, moving over the road, or being loaded or unloaded.

An accepted design figure for shock is 15 G's. This requirement automatically eliminates many instrument designs which are suitable for stationary or laboratory use. Real delicate switching arrangements or meter movements are out. Sensing elements, mechanisms, chart marking systems, etc. must be husky and heavily sprung. Certain filled system designs have inherent ruggedness that makes them readily adaptable.

Most controls at this time use snap-acting switches. This type of switch can be prematurely toggled by shock if the switch is about to toggle anyway. Since shock is not normally a repetitive phenomenum, neither the switch nor the refrigeration unit will be damaged by an infrequent short cycle. Vibration is a horse of a different color. It can cause the contacts of a snap-acting switch to bounce, particularly when the switch has just toggled, as there is almost no contact force at that time. Any bouncing of the contacts causes arcing, which in turn melts the contact material and can cause welding or sticking. Vibration mounting or dampening of the control may be necessary in some cases to give prolonged switch life.

As for reliability, a control properly installed should last the life of the refrigeration system. The thermal sensing elements will go for ten years at least without any maintenance.

The control bodies do require some minor maintenance, particularly on container units. Salt air and salt spray are very insidious. They will penetrate the deepest corners. For that reason, seagoing units must be sprayed periodically with special corrosion proofing and lubricating sprays such as CRC 3-36 to prevent electrical shorting and binding due to corrosion.

The snap-acting switches mentioned previously have been specially selected. The movable beryllium copper spring is coated so it won't fail due to stress corrosion. The switches usually are downrated electrically from the die label rating. Why? Because a minimum of 1 million cycles is desired and the die label switch ratings are obtained from U. L. if the switch will go 6,000 cycles. Further, temperature controls operate the switches on their differential only (no pretravel or overtravel of the plunger), which is much harder on the switch contacts due to lack of contact pressure under these circumstances. D-C current is more difficult to handle than A-C. Some form of contact protection is often necessary with D-C to provide adequate life.

Now let's get to one of the most important points—accuracy! I believe that without exception all control manufacturers in the mobile field claim an accuracy of approximately 1% of scale range or about ±2°F. This does not mean that closer accuracies can't be obtained at a particular temperature. The common practice is to try to obtain maximum accuracy at the freezing point, or 32°F. This is done by zeroing at this temperature.

Let's not kid ourselves, getting closer than ½ to 1° to a true temperature is extremely difficult. To illustrate, our master laboratory temperature reference which is periodically calibrated by the Bureau of Standards is only certified within ±0.2°F. Check instruments used to field check the controls are not this accurate. Usually they fall in the same accuracy category as the temperature control. Then the question arises as to which is the nearest to the true temperature.

Further complicating the situation is the fact that most check instruments get out of calibration easier than the controls. This is due to their design being less rugged and the rough handling given them in the field. On top of this, they are often not utilized correctly in the first place, which leads to all kinds of recalibration or zeroing inaccuracies.

To help out in this problem, control manufacturers are now offering check probes integrally mounted to the control probe. They also are offering tools to easily and accurately check the test instrument body at specific temperatures. This program should cut down on the inaccuracies of field calibrations, but still that last one degree of accuracy is an elusive thing.

Ambient temperature also affects control accuracies. A unit may be subjected to a wide range of ambient temperatures, from -20 to +125°. The liquid fill used in the control sensing bulb also fills the capillary. It must be compensated for or it can cause at least a 4° or 5°F errors. When the capillary itself is compensated, only minor ambient errors exist due to the control bodies. They do not exceed $\frac{1}{2}$ to 1°F.

All mechanical units are subject to some wear. This is true of the control mechanisms. Our tests indicate that the complete unit should not lose more than 1° per year for all reasons. In fact, after an initial "settling in" period, the loss is nearer $\frac{1}{4}$ to $\frac{1}{2}$° per year.

Snap-acting switches do not always toggle at the exact same point each time. This is not due to vibration, but is an inherent shortcoming. The toggle point can vary as much as $\frac{1}{2}$°. This of course puts a limit on how close switches can be set sequentially without danger of overlapping. 1°F differential between switches seem to be a minimum for most manufacturers.

As you can see, one of the weakest points in the control is the snap-acting switch. So-called solid state components are rapidly decreasing in price while increasing in reliability. They appear to be the answer to the switching problems, and probably will replace the snap-acting switch in the future. At this point they are quite a bit more expensive for equal reliability.

Most refrigeration systems operate in three or more stages. The tendency is for more, rather than fewer, stages. Four stages means the controls must have three thermally operated switches set in sequence with a definite relationship to the set point of the control. For example, on a temperature drop, the unit will stay in full capacity cooling until the temperature is 2° above set point. It then kicks into partial cooling until the temperature drops to set point. Then the system shuts off. If the temperature continues to drop, heating will cut in 2° below set point. There are many variations of these settings; however, what I am trying to point out is that temperature change is required within the container to cause the refrigeration unit to pass through its various stages.

Usually the unit will cycle between partial cooling and off. Depending on the switch differential, the air temperature varies 1 or 2°F at least, under this condition. Rarely does the load just balance the output of the refrigeration unit at partial capacity and allow the temperature to remain constant.

At times the ambient temperature variation may force the unit to go to either full capacity cooling or heating. This means even wider air temperature variation from set temperature. If the setting were as I gave in my example, it could mean at about a 3° to 4° deviation from the control set point temperature. If the air temperature change is of sufficient duration, the load must also change temperature.

The span of temperature included in the switch sequence and its relationship to the control set point, largely determines how much the load temperature will vary from the control set point due to the control.

At the present time, the most popular location for the thermal sensing probe is in the return air to the evaporator. There are advocates for positioning it in the outlet air. I do not want to get into that discussion at this time. All I want to point out is that wherever the sensing probe is positioned, the temperature at that point is the only temperature the control can sense and control by.

If the load is packed tightly from floor to ceiling and the air short cycles between the evaporator outlet and return, the control does not know the difference. It senses the cold air temperature flowing over it and signals the unit to the appropriate stage for that temperature.

In the same vein, the control has nothing to do with the number of degrees that the air changes temperature as it passes through the evaporator coil (excepting for changing stages). If the air leaving the evaporator is so cold it damages the top of the load, the control is not responsible. That is a problem of the refrigeration system manufacture. The effects of poor insulation or leaking doors and joints are also something the temperature control can do nothing about.

The checking of container temperatures while aboardship is a problem. They may be piled three high on the deck, and who wants to climb up 25 feet when the ship is rolling 30°? One approach to solving this problem has been to incorporate temperature "in-range" switches in the control. We refer to them as idiot light switches. One switch is set to actuate 4° or 5° above and the other 4° or 5° below the control set point. At times one switch has been used to depict this "in-range" 8-10° span.

Either way, if the temperature goes out of this span, lights on the bridge go out to warn the crew to check that container.

Lately we have been hearing rumors of using a separate sensing device attached to the control probe and tied into a shipboard computer to routinely check containers. The probe would be much like the zeroing unit I mentioned previously. I don't think this has actually become a reality as yet.

From time to time human errors cause control problems. Someone who is accustomed to dealing only in Centigrade comes up against a control with Fahrenheit charts. Inadvertently he makes the Centigrade setting on the Fahrenheit charts, or vice versa. To help combat this, charts are being printed with large, bold "F's" or "C's" on the chart face. Also, new charts will have a wedge that shows the temperature relationship between Centigrade and Fahrenheit. Hopefully this will help the setting problem.

Separate setting scales with larger divisions are being tried by some to prevent mis-settings of controls. Digital setting scales can be supplied. These and other possibilities exist but most of them cost additional dollars. The container owners or operators has to determine what new designs are economically feasible, and are to be pursued. We as control manufacturers are ready to try to provide just what is desired or required.

I hope the above gives you some idea of the current "state of the art" as far as control capabilities are concerned.

MARKETING POTENTIAL - FRESH FRUITS AND VEGETABLES

A. Clinton Cook
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Foreign Agricultural Service, USDA

Although there are always many problems associated with foreign trade in maintaining and developing markets for horticultural products, prospects right now look good. We will lose markets for some products and gain others. In FY 1972 we exported $662 million of horticultural products for an all-time record, and despite many short crops, we may hit $750 million this fiscal year.

There are three major important factors for refrigerated or, we might say, perishable horticultural products. They are:

1. Total time in transit from point of origin to receiver's warehouse.

2. Total cost of transportation, including documentation.

3. Market access including duties and non-tariff barriers.

American industry created a dream world for moving foods when it developed the intermodal containers service. The only problem remaining is to coordinate the system into a fast and efficient service from original shipper to final receiver. To do this, all modes of transportation are needed and vital to the integrated system. This means that truckers, rail systems, airlines and ocean shipping and, above all, the government regulatory agencies must work together.

The U.S. transportation system is capable of moving perishable produce from any point in the United States to anywhere in Europe or Japan in 12 days or less depending on the point of origin. This means that all horticultural products except the most perishable, such as strawberries and fresh asparagus, can move by surface.

The intermodal containers are not truly intermodal because ship lines will not allow their limited supply of reefers to move transcontinental and refrigeration equipment of the containers is not inter-changeable with the different modes of transportation. It is costly and damaging

to produce to unload and reload at shipside. Worldwide, most container lines settled on the 40-footer except one U.S. line which adopted a 35-foot container. Imagine shipping a 40-foot container to port and trying to stuff the produce into a 35-foot space.

Trucks can move produce from any point in Florida to any point along the East Coast in two days or less, and to the West Coast in three to four days. Rail lines will not guarantee any time schedule, but unit trains could equal or surpass the truck time. Probably ocean lines will not let their few refrigerated containers go transcontinental because it takes them about 30 days to make a round trip by rail.

Over time, rail lines, at the insistence of the produce industry, have agreed to five diversions—one free, and four at a nominal cost—from West to East. This means that cars can be stopped and held in diversion yards five times; this causes damage in switching, delays in transit, quality deterioration, and lost cars. These unsold rollers are used for market speculation. These five diversions probably cost the rail lines more than it does to move the car from California to New York.

I believe that in a few years most fresh produce will be grown under contract with an agreed-to weekly shipping schedule. When this is done, shippers, receivers, and the transportation system can plan ahead to handle the traffic.

Government regulatory agencies have required the rail lines to maintain unneeded spur lines and to pull unwanted passenger trains. Why not let them merge into a few efficient transcontinental systems and use motor trucks for the pick-up and final delivery?

U.S. horticultural growers are quite efficient. Transportation costs have often nullified their efficiency and this is especially true in international markets. The cheapest transcontinental haul is by rail. Equipment needs can be cut almost in half by making the most efficient use of our transit system. This will mean some changes by shippers, the transit system, and government regulatory agencies.

Current equipment does not always maintain the needed temperature throughout the load for the entire journey. This may be caused by failures of the equipment, the loading patterns used by the shipper, or both. A major shipper of bananas has just issued a news release stating that their new containers will maintain a temperature within

2^{o} F. throughout the load of bananas from the tropics to any point in the United States. If this can be done for all containers, I am confident that it is possible to virtually eliminate bad arrivals overseas. Then, damage claims would be minimal.

Our record in freeing international trade is not good. The EC is now nine countries and they have special bilateral arrangements, usually duty preferences, with about 65 other countries. With their Common Agricultural Policy they can stop trade any time it suits them. Japan has never truly liberalized any item—agricultural, industrial, or shipping. Japan continues to use exorbitant duties, quotas, unreasonable and often changing regulations, and, if these actions are not effective in controlling trade, then "administrative guidance" is used. Just to use a couple of examples, a year ago last July, Japan liberalized fresh grapefruit but at the same time imposed a 40 percent c.i.f. duty for most of our season. Even with this handicap, exports increased sharply, but now they are promoting a "one window" importer so that control is shifted from government to industry. Prepared frozen foods carry a duty of 35 percent of the c.i.f. value, but virtually none of our foods are cleared by Japanese customs for one reason or another.

If the U.S. Government can do a reasonable job in maintaining access to foreign markets there should be a substantial increase in exports of horticultural products. I am preducting that we will about hold our own in Europe with a substantial increase to Asia, particularly Japan, and perhaps to Brazil. Exports to Japan alone would increase from the current $70 million to $300 million to $500 million in a few years.

Rough estimates show that we export the equivalent of 18,000 40-foot containers to Europe and that may not grow much. To the rest of the world except Canada, we could move up from our present 30,000 to almost 60,000 containers. Some of the growth items appear to be iceberg lettuce, other fresh vegetables, and citrus juices to Europe; to Japan, fresh citrus, citrus juices, melons, fresh vegetables, and frozen foods appear promising.

In summary, I am confident the technical problems can be quickly solved—though not easy, the coordination of fiercely independent transportation systems can be accomplished; but I am less confident of Government. Regulatory agencies need to take a more practical view of the total transportation system. Our trade negotiators need to get tough.

It should be possible to export more than a billion dollars of horticultural products. To achieve this goal it will require a lot of hard work on the part of all participants.

U.S. Exports of Perishable Horticultural Products to Europe and to Other Countries but Excluding Canada

Product	Approximate 40-foot Containers			
	1971-72		1976-77	
	Europe	Other	Europe	Other
	Containers			
Apples	5,400	9,900	—	10,000
Pears	3,000	3,200	1,000	3,500
Grapes	200	500	500	2,000
Oranges	3,000	6,000	2,500	16,000
Grapefruit	1,000	5,000	2,000	12,000
Lemons	3,000	5,000	3,000	6,000
Citrus Juice S/S	1,000	200	1,000	200
Citrus Juice Concentrate	900	100	2,000	4,000
Lettuce	200	—	5,000	1,000
Watermelons	10	—	200	—
Melons	—	—	—	600
Onions	250	250	250	250
Other Fresh Fruit	—	—	200	—
Other Fresh Vegetables	160	—	500	500
Total	18,120	30,150	18,150	56,050
Grand Total	48,270		74,200	

MARKETING POTENTIAL-FRESH MEATS & POULTRY

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If you can bear with me for a minute or two I would like to point out the trade volume for the calendar year 1972 of the total commodities in the animal product sphere. Roughly, total world trade in agricultural commodities in 1972 exceeded $50 billion, and about one-fourth of this or somewhere around $13 billion was in livestock products.

The big volume items, of course, in world trade are grains that have a low per ton value and the cheapest per ton shipping costs. By comparison the animal products of meats of all types, butter, cheese, wool, hides and furs, and others have high unit values, are generally perishable, with per ton shipping returns high. Looking at containers in a broad sense, nearly all of these commodities with the exception of live animals and animal fats lend themselves to container service. Even commodities such as lard and tallow that require pumping discharge could go to containers if the conventional deep wells disappear. Of course, the opposite of refrigeration, heat, would be the requirement. This audience may not share my amazement of the quantity of wool and hides that are today containerized.

U.S. Trade in Meat Products

In 1972 exports of livestock products exceeded $1.1 billion and imports were just short of $1.9 billion. Within this overall category, exports of red meats totaled 75,000 metric tons, variety meats or offal were 126,000 metric tons, and although I don't have the tonnage dairy and poultry exports were worth $228 million. On the import side, red meats are the principal item totaling 903,000 metric tons with a value of $1.2 billion. All of these meats require refrigeration, and the absence of such is rapidly revealing.

U.S. exports of meat products and, indeed, the world trade have grown rapidly in recent years. Demand in nearly all countries and particularly the more developed nations continues to build for red meats and particularly beef.

The refrigerated container has been a tremendous asset to the movement of meat and poultry. Never before have we known such service where a plant in Colorado can load his product in a container at his dock and deliver it to his customer's unloading platform in Dusseldorf, Germany. The product can arrive in excellent condition and with a minimum of delay, extra handling and pilferage.

The majority of meat and poultry products move in frozen form. Our industry and marketing experts generally agree that for efficiency all meat trade, domestic and international, should be in a frozen state. However, to date they cannot convince the end-user or customer, the housewife, of this feature. She does not trust that frozen meat package as, historically, she has been burned on quality with the frozen product. Slowly in this country and in Europe, plus a few others, trade in some products such as turkeys, Cornish hens, fish, and perhaps to a lesser extent broilers, has begun to move in frozen form. However, the big demand for table meats continues to be as fresh or chilled. Refrigerated containers have and can facilitate this trade.

More tonnage would move in trade if the container service were available and could meet the critical requirements. To ship chilled meat requires a continuous temperature of plus or minus about $32 - 34^{o}$ F. Anything less than about $29\frac{1}{2}^{o}$ F. produces ice, and above 34^{o} F. encourages bacterial growth. Trade in chilled meats is growing. The old tradition of Argentina moving bone-in beef quarters and sides to Europe has given way to boxed boned primal and sub-primal cuts in Cryovac and shipped chilled. Most of this is still shipped by conventional reefers. Now fresh chilled beef cuts can be shipped in Cryovac and "age" enroute.

About seven or eight years ago our Department technicians, along with the Department of Defense, made some studies on shipping chilled beef to Europe. The container shipments at that time were completely unsuccessful. Effective temperature control was simply inadequate. However, more recently some fine examples of good service with containers have developed. There have been several movements of chilled beef from Colorado to Japan. This involved about 14 days transit, and the meat arrived with a beautiful bloom. Australia and New Zealand have made numerous shipments of lamb and beef to Canada and the United Kingdom. Australia shipped over 12,000 tons of chilled beef in containers last year to Japan.

The new technique is to let the beef cool out for 24 hours following slaughter. After 24 hours the carcass temperature will be in the low 40's and the interior meat—such as the rounds—may be around 50°. An extra 24 hours could pull the temperature lower. Either way the meat is placed in Cryovac with the oxygen withdrawn, creating a vacuum. The product is then put through shrinking so that in fact the Cryovac becomes a new skin. The product is loaded immediately in a refrigerated container and is on its way to the overseas customer. The meat ages and further cools enroute and will arrive in optimum condition up to 20 days. That is, provided the temperature holds within the critical range. This puts the onus for temperature control on the carrier.

In summary — trade in meat and poultry, as well as nearly all of the animal products, is growing in both the United States and in world trade. The demand is for quality products such as the U.S. produces. We are the most efficient poultry producer in the world—no one is even very competitive. We can compete with anyone in pork production, and with the exception of a very few producing nations we are very attractive with our beef prices. When it comes to quality beef, the United States is supreme. When beef prices in Europe and Japan are well above U.S. prices, as they are now, it is puzzling that exports do not increase in spite of all the problem barriers.

This trade will increase both as it relates to the United States and to the world. Refrigerated containers can exploit the developments. U.S. carriers and container services should get a much larger piece of the action but they must compete in price and render service.

MARKETING POTENTIAL–QUARANTINE REGULATIONS & FUMIGATION TECHNIQUES

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The Animal and Plant Health Inspection Service is the newest of the 22 Services of the U.S. Department of Agriculture. The Service was established on April 2, 1972, with Dr. Francis J. Mulhern as the Administrator. It consolidated various regulatory agencies of the U.S. Department of Agriculture into a single cohesive unit. The purpose of the reorganization was to improve our ability to marshal manpower and resources when and where they are needed to combat the introduction and spread of agricultural pests and diseases, to make more effective use of our total staff of quarantine inspectors at ports of entry and plant protection specialists located throughout the United States, and to more effectively coordinate the work of safeguarding environmental quality. The new APHIS organization emphasizes the positive aspects of protecting American agriculture from agricultural pests and diseases rather than controlling and eradicating these pests and diseases after infestation and destruction have occurred.

To keep plant pests from entering the United States and becoming established in our agricultural crops, we have developed many treatments. These treatments include chemical treatments, heat treatments, utilization treatments, and treatments with cold temperatures. Some temperatures, such as quick-freeze at temperatures several degrees below zero, eradicate the pests. The treatment which we want to talk to you about today is a treatment which we call intransit cold treatment, or treatment above freezing. The specific treatment utilizes temperatures of 32 to 36° F. in 1-degree increments. The original data for this treatment were worked out in 1938. Due to World War II, we were unable to use the treatment on vessels until after the war. In order to work out the treatment, 160,000 life forms of the Mediterranean fruit fly were exposed to prolonged cold to determine the time and temperature required to kill the various life forms of the insect. It was found that, after precooling the fruit to carrying temperatures, any of the following combinations would do the job:

10 days at 32°
11 days at 33°
12 days at 34°
14 days at 35°
16 days at 36°

The temperatures are very specific and if they rise even 1 degree above 36°, the insect can survive unless the treatment is started over again. It is for this reason that we must have an even temperature in the commodity throughout the cargo space to have a successful treatment. Unfortunately, there is no way to reduce the cold exposure time requirement to give more latitude to the newer vessels which have shorter and shorter transit times, or to compensate for temperatures in commodities which have a range of change greater than that mentioned above. This treatment has allowed agricultural commerce to move from countries where the Mediterranean fruit fly occurs to those that do not have the pest. The cold treatment above freezing principle has been applied successfully to other tropical fruit flies.

Briefly, the intransit cold treatment is designed to fully utilize the refrigeration facilities on maritime modes of transport. The fruit must be precooled either in cold storage warehouses ashore prior to loading or on vessels that have the capacity to complete the precooling.

The break-bulk refrigerator vessel is ideally designed to complete the intransit cold treatment. New vessels have the capacity and can precool fruit from ambient temperatures to carrying temperatures in a few hours. This is partly made possible by ship design and the ability to periodically reverse the direction of air flow in the cargo space.

We have required that dunnage spacers be used in cargo holds to insure a free flow of refrigerated air to all parts of the fruit cargo under treatment. Stow patterns are being changed on vessels to eliminate dunnage if the vessels can demonstrate that their plant can cool the cargo efficiently. Savings are made in refrigerated space and in costs for dunnage materials and costs for the labor to place the dunnage into the cargo as it is loaded.

For vessels to obtain approval, owners are required to submit plans of the refrigeration plant and location of temperature sensors. Air temperature records are needed in each cargo space but most of our records are those taken in the pulp of the fruit. The number of pulp sensors is governed by the size of the cargo space. A minimum of two air and two pulp sensors is required. Performance standards are published for temperature recording equipment and temperature sensors. When the equipment is installed, we conduct an approval test of the equipment.

When fruit is loaded in a foreign country for intransit cold treatment, the country will furnish a certifying official to test the equipment for performance. He will place the temperature sensors in the fruit and certify the beginning of the temperature record. The official sends this information to our Inspector in Charge at the U.S. port of entry, and leaves a copy with the master of the vessel. The U.S. inspector boards the vessel on arrival at a U.S. port, reviews the temperature record, and releases the cargo if the record shows a good treatment.

The imported fruit season is off-season fruit and the major amounts of fruit enter from January to June each year. The figures which follow will be a total for each country.

Argentina, 47,706 boxes of apples and pears
Australia, 358,848 boxes of apples and pears
(37,912 boxes were treated in the Associated Container Transport Line, Ltd. containers)
Chile, 1,361,790 boxes of apples, grapes, nectarines, peaches
Colombia, 3,000 boxes of grapes
Israel, 243,269 boxes of oranges
Republic of South Africa, 364,230 boxes of apples, grapes, pears.

This is a total of 2,378,843 packages of fruit, which were treated while en route to this country on maritime facilities. A total of three million packages of fruit are being imported each year.

The container is pressing the break-bulk vessel for most of its cargoes. Refrigerated cargoes are under the same pressures. New vessels are being built with greater spaces for refrigerated container cargoes. The LASH barge type containers are under tests to determine if they can be used for refrigerated fruit cargoes. We have seen the shift to containers coming and have redesigned our treatment for containers.

When deciduous fruit is fumigated with methyl bromide at 70° F. and refrigerated within 24 hours, refrigeration treatment times and temperature requirements can be reduced in some cases. This is because the cold adds a killing factor to the fumigation in the cases of the Mediterranean fruit fly. The treatment has been titled "Fumigation Plus Refrigeration". Let's compare it with our standard intransit cold treatment.

Fumigate deciduous fruit at 70° F. with 2 pounds of methyl bromide for 2 hours. Precool the fruit to 37° F. or below. Hold the fruit at that temperature for 4 days and you have an acceptable treatment for the Mediterranean fruit fly, just as good as fruit held 10 days at 32° F. or 16 days at 36° F.

We can get good treatments at higher temperatures by extending the exposure period of the fruit to the methyl bromide gas. For example, using the same dosage of 2 pounds of MB at 70° F. but exposing the fruit for $2\frac{1}{2}$ hours instead of 2 hours, we only need to hold the fruit at 40° F. for 4 days. If we extend the exposure period to 3 hours with the same dosage and temperatures, we need only to hold the fruit for 3 days at 47° F. or below, or 6 days at 56° F. or below. The fumigation plus refrigeration treatment was commercially tested in Chile two years ago. The exporter reported a very satisfactory financial success in spite of the fact that he paid air cargo rates from Chile to California. Most of the cargo was stone fruit; nectarines, peaches, and plums.

The intransit cold treatment or fumigation plus refrigeration has not been used in containers with diesel/electric powered refrigeration units. Containers have been approved for intransit cold treatment on vessels of the Associated Container Lines, Ltd. These are 8' x 8' x 20' containers that are stowed in a refrigerated hold which maintains temperatures of 40° F. or below. Refrigerated air is distributed through ducts to a 24-container unit from a machine on the vessel.

Container cargoes of pears and apples must be precooled in the exporting country. A disposable thermocouple is inserted into the fruit in a box which is located near the center of the load. One-half of the containers that will be placed in designated positions in the 24-container bank will have a resistance thermometer sensor inserted in the pulp of the fruit instead of a thermocouple. All fruit must be packed in a standard box and vertical dunnage spacers are required every second row to provide for air circulation. The air is delivered from the floor through the cargo. When the containers are loaded on the vessel, the representative containers with resistant thermometers are monitored by a strip chart, a temperature recording device installed for that purpose on the vessel. The entire unit of 24 containers is treated as one for treatment purposes.

The vessel of the ACT are carrying Australian apples and pears. The vessels do not have the capability to precool from ambient temperatures to treatment temperatures. However, the long voyage time does give the vessels time to precool fruit from about 48° F. to treatment temperatures. Treatment for Queensland fruit fly is 13 days at 32° F. or 14 days at 33° F. In early voyages, it has taken as long as 7 days to reduce fruit pulp temperatures in all the containers a few degrees. Improved techniques should reduce these times this shipping year.

Although we have had the intransit cold treatment and the fumigation plus refrigeration cold treatments available for some time, there are no approved containers which have fixed self-powered diesel/electric refrigeration units. To our knowledge, 40-foot containers with the standard nosemount refrigerated units, with one possible exception, have not been able to provide uniform temperature distribution in commodities in the temperature range of 32° to 36° F. which are needed in our treatments.

A series of tests has just been completed which indicates that one container could possibly meet our temperature criteria. This container has a nosemount refrigeration unit with under-the-load air delivery system. The fiberboard boxes used to carry oranges were designed with a vertical under-the-load air delivery system in mind. The vent area of the box totals 3.7% on the top side and 4.4% on the bottom. A lateral vent area of 3.7% is provided in case the carton is carried in a different refrigeration system. From the test, it appears that the vent area could be increased. The standard Florida citrus box has a total of 0.04 square feet of vent space. The citrus box we tested had a total of 0.06 square feet of vent area and at least doubling that area appears desirable.

The load used was a solid block stow, 5 x 5 offset 6 high. It was stacked in 33 rows, each consisting of 30 boxes of citrus, giving a total of 990 boxes. The shippers of the citrus intend to increase the size of their box to provide a solid block stow, 5 x 5, 6 high. The solid block stow would just fit the cargo space of the 8' x 8½' x 40' container. The owners of the equipment believe this tight stow will increase the efficiency of the air distribution system. An additional test will be needed with an actual cargo of oranges to determine if this will be so.

The refrigerated break-bulk vessel can obtain temperature-reading equipment to meet the performance requirements. However, there is no equipment available for the containers. We are aware of one temperature recorder

which has the required accuracy. However, it will have to be redesigned to fit into a marine environment on the container. We have suggested that container vessels have one temperature recording device for several containers installed in a central location on the vessel. Individual containers could then be identified and monitored from one strip-chart record.

Our tests with actual citrus loads in the container previously mentioned, which was instrumented with several sensors located in orange pulp, showed even temperatures in most of the container space. These tests indicate that we need two sensors, each located in the fruit, one in row 33 and one about row 9 or 10. Eventually, one sensor may be all that is necessary and the location would appear to be in row 33.

We hope that more refrigerated containers can be approved to carry fruit for intransit cold treatment. To obtain approval, containers must be designed to maintain fruit temperatures within the narrow temperature range required for treatment. Also, the industry must furnish an inexpensive temperature recording and sensing system which will indicate actual pulp temperatures. Since we are a regulatory agency, our activities to develop improved containers are limited. We work through the ARS and with industry to make performance tests of equipment needed for our treatments.

I would like to conclude by quoting some remarks made by a world authority in refrigerated cargoes at a joint international meeting held in Wageningen, Holland, between the refrigerated land and the refrigerated sea transport representatives.

"The United States has realized a side benefit in better quality Australian apples because its quarantine cold temperature requirements for fruit fly control specify that the fruit must be precooled to 45° F. or below, loaded into containers, and held at 32°-33° F. throughout the voyage. As a result, Australia sends only properly precooled apples to the United States, while apples at higher temperatures are shipped to Europe, which does not have a strict temperature requirement."

MARKETING POTENTIAL-QUALITY MAINTENANCE OF FRUITS AND VEGETABLES

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Introduction

Quality of fruits and vegetables can be defined as "the appearance, texture, odor, and taste of any particular product at any particular time, by a particular person". In other words, a product that represents high quality to one person may be unacceptable to another. Certain criteria or standards, generally are considered in evaluating the quality of fresh fruits and vegetables. Methods to maintain high quality will be discussed briefly under appropriate headings.

Maturity

The stage of maturity at which a product is picked plays a vital role in its quality after harvest. Each crop has its proper picking maturity. Certain fruits such as peaches, apples, pears, tomatoes, and bananas, will ripen after harvest. Such fruits may be picked hard-to-firm or green but at a stage when they will ripen after harvest to highest quality. A second group, containing grapes, citrus, figs, cucumbers, and certain melons, will not ripen after harvest and must be picked in the correct stage for eating. The contents of soluble solids, sugar, and acid as well as texture, odor, appearance are some of the factors which govern picking maturity. If we expect to take a product of high quality out of a container we must put a product of high quality into that container. Proper picking maturity can govern the quality of a product when it is placed in a container. Proper storage and transit temperatures and postharvest treatments can govern the quality of a product when it reaches the market and the consumer.

Refrigeration

Each fruit and vegetable has its proper temperature for storage and transit. All leafy vegetables and others such as corn, peas, and carrots, fruits such as berries, and stone fruits, and most cultivars of apples must be stored near 32° F. After harvest they

should be cooled to 32^{o} as rapidly as possible to maintain highest quality. Usually hydrocooling or vacuum cooling will cool the produce more rapidly than air cooling.

Other vegetables and fruits should be stored and shipped at moderate temperatures (Table 1). These commodites are subject to chilling injury which may occur near 32^{o} F. Green beans, bell peppers, and summer squash for example can be considered moderately susceptible to chilling and should not be stored or shipped below 45^{o}. Other commodities such as eggplant, mature green tomatoes, bananas, sweetpotatoes, grape fruit, and pineapples are very susceptible to chilling and should not be stored below 50^{o} to 55^{o}. With these commodities precooling consists of removing the field heat to the desired storage temperature.

If high quality is to be maintained each fresh fruit or vegetable has a limited storage life even at the optimum temperature. For example, vegetables such as sweet corn, lima and green beans can be stored only about a week; lettuce and celery, 3-4 weeks; and other vegetables such as cabbage, white and sweet potatoes can be stored many months. The same is true of fruits with the storage life of strawberries and blackberries only 3-7 days, stone fruits 2 to 4 weeks, while other fruits, such as several cultivars of apples and citrus, can be stored many months.

Improper length of storage will cause various types of physiological breakdown often attributed to aging or senescence. Stone fruits for example may develop various degrees of breakdown such as brown or red discoloration of the flesh, grainy or wooly texture of the flesh, and loss of flavor. Usually flesh breakdown does not occur until the fruits are transferred from low to high temperatures. Even at the high temperature the fruits may appear healthy externally. Brown core of pears is another defect caused by prolonged storage. With vegetables, such as cabbage, yellowing may be a sign of aging. Of equal importance, fruits and vegetables stored too long are more susceptible to decay-producing organisms than those stored only for acceptable times. In all cases improper storage temperature accentuates injury caused by prolonged storage.

Respiration is one of the chief processes affecting the quality of fruits and vegetables. Usually the more rapid the respiration the more rapid the deterioration. Refrigeration is the best method of slowing the respiration rate. Generally for every 18 degrees increase in temperature,

between 32° and 80° F, respiration rate is doubled or tripled. Therefore, for cold-tolerant crops low temperature is the best way to preserve quality. With cold-sensitive crops, respiration rates may increase abnormally when the produce is removed from low temperature and deterioration may be more rapid than in non-chilled products.

Modified Atmosphere (Controlled Atmosphere)

Modified atmosphere or CA storage is another method of reducing the respiration rate of fruits and vegetables during storage and transit. CA is achieved by lowering the oxygen (O_2) content of the air and or increasing the carbon dioxide (CO_2) content. CA should be considered as a supplement and not a substitute for proper refrigeration. Each commodity has its specific O_2-CO_2 requirements for correct CA storage.

Only for apples is CA used extensively for commercial storage. Eight cultivars of apples are suitable for CA storage; they can be stored in atmospheres that range from 1.5 to 5% CO_2 and 2.5 to 3.5 O_2 for at least 6 months. While most cultivars should be stored at 32° F, McIntosh apples should be stored at 38° to 40° in an atmosphere of 3 to 5% CO_2 and 3% O_2. A physiological disease of apples known as "Jonathan Spot" can be controlled by storage in an atmosphere of 2.5 to 5% CO_2.

CA conditions also extend the storage life of peaches, nectarines, and tomatoes. Peaches and nectarines can be stored successfully at 32° F in an atmosphere of 1% O_2 + 5% CO_2 about 3 weeks longer than in air. Mature green tomatoes stored in an atmosphere of 3% O_2 and zero CO_2 for 6 weeks at 55° F developed less red color than those stored in air. The addition of 5% CO_2 further delayed development of red color but sometimes injured the fruit. Fruit from the 3% O_2 + 0% CO_2 and 3% O_2 + 5% CO_2 ripened to full red color within 2 weeks in air at 60°.

Lettuce is the only vegetable shipped extensively under CA conditions. When O_2 during transit is ¼% or lower the butts of the lettuce remain white, but sometimes development of injury in the form of pink rib is stimulated and black veins may develop in wrapper leaves. A transit atmosphere from 1 to 8% O_2 will lower the incidence of russet spotting from that in 32° F air. Another disorder of lettuce known as "brown stain" increased when CO_2 in the cars increased to more than 2%; this level of CO_2 also caused death of heart leaves. Careful control of the atmosphere therefore is necessary in order to avoid these injuries.

Very high concentrations of CO_2 (20-30%) sometimes are used in shipments of strawberries and sweet cherries. Today many of the strawberries are shipped by air in film-covered pallets. High CO_2 is obtained by dry ice. The treatment retards but does not prevent decay development.

A recent type of atmospheric modification is hypobaric storage in which produce is held at less than normal atmospheric pressure with the aid of vacuum pumps. During hypobaric storage, ripening of tomatoes was delayed and the storage life of strawberries (at 40° F) extended. The greatest delay in ripening and greatest extension of storage life was at the lowest atmospheric pressure tested ($\frac{1}{4}$ atmosphere). On removal from hypobaric storage tomatoes ripened normally and both tomatoes and strawberries retained normal flavor. The treatment is not used commercially.

Decay and Its Control

During storage and transit decay or disorders may be caused by parasitic microorganisms and by physiological breakdown. Organisms causing most serious losses are species of the fungi *Botrytis*, *Penicillium*, *Alternaria*, *Diplodia*, and *Monilinia*, and by species of the bacterial genera *Erwinia* and *Pseudomonas*. Most of these organisms can grow from about 32° F to near 90°. Most of the physiological disturbances are closely allied with aging or with improper storage temperatures and atmospheres.

Low temperatures slow the growth of pathogenic organisms and should be considered the chief method of controlling decay. Even with cold-sensitive commodities less decay will develop at 50° F than at 70°. Unfortunately low temperatures during storage offer essentially no protection against decay when the produce is transferred to higher temperatures. Supplements to refrigeration such as chemical and heat treatments or combinations of the two help to control the decays and physiological breakdown especially after transfer to higher temperature.

Chemical treatments to control postharvest decays or physiological breakdown have their limitations. The Food and Drug Administration and Environmental Protection Agency regulate use of the chemicals to control postharvest disorders and establish permissible residue levels of these chemicals in and on foods. Many chemicals, highly toxic to decay-producing organisms, are eliminated from use. The few that can be used are specific against certain organisms, and can be used only on specific crops. Often a material that effectively controls decay of one crop will severely injure another, or cause off-flavor. Outstanding examples of this are biphenyl which can be used safely on citrus and sulfur dioxide on vinifera-type grapes. Either chemical will severely injure other crops.

Chemicals may be used as postharvest dip or wash treatments, (often in hydrocoolers), as gas or fumigation treatments, or as preharvest sprays. Several chemicals will control decay due to several genera of fungi but we have nothing that effectively controls decay due to bacterial organisms. The most widely used chemical is chlorine or its compounds. Other chemicals recently found to be very effective against certain decays are: benomyl, thiabendazole, and 2-aminobutane. They are particularly effective against diseases of citrus where they are replacing biphenyl and sodium o-phenyl phenate (SOPP). Benomyl also is very effective in controlling brown rot of peaches. Another relatively new material, botran (DCNA), is particularly effective against rhizopus rot of peaches and sweet potatoes. Thiabendazole and 2-aminobutane are approved for use on citrus, benomyl and botran for stone fruits and botran for sweet potatoes.

Hot-water treatments have shown considerable promise for reducing postharvest decays. These treatments have two advantages over chemical treatments: (a) they destroy decay-producing organisms in and on the produce, and (b) they leave no chemical residue. Care is necessary to maintain correct water temperature and exposure time to avoid injury to the produce, and to maintain sanitation during packing and shipping to avoid recontamination. Hot-water treatments for 2-3 minutes in 125° F water are used successfully commercially to reduce decay of peaches, mangos, lemons, and papayas. Hot water also shows considerable promise of reducing fungal decay of melons, sweet potatoes, sweet cherries, and storage scald of certain cultivars of apples.

Combinations of hot water with certain chemicals have improved the efficiency of both the hot-water and chemical treatments in reducing decay.

Hot air of high relative humidity also may be used to control postharvest decays of certain crops particularly strawberries, peaches, and sweet potatoes.

<u>Shipping containers</u>

Protection of fruits and vegetables depend on the type of shipping container that is used. A "bruise" has often been said to be the worst defect of fruits and vegetables. It not only makes a site for entrance by pathogenic organisms, but also increases the respiration rate of the produce and hence

increase metabolic deterioration. Most modern containers have been designed to keep brusing to a minimum. The use of tray packs, films to keep relative humidity high, and hence reduce shriveling, and the fiberboard boxes all have reduced the injuries, particularly of fruits, previously shipped in baskets.

Today there is much interest in compartmentized shipments. The specific requirements of different commodities reported here should serve as a warning if this type of shipment is used. Improper grouping of cold-tolerant and cold-sensitive produce may severely injure the latter. Volatiles from chemicals used on one type of produce may severely injure another type, as already has been mentioned (fig. 3B). Volatiles produced by plant materials, however, have not been discussed. Ethylene, for instance, is known to stimulate ripening. Apples produce large amounts of ethylene, which could for instance accelerate ripening of tomatoes. Even relative humidity can cause conflicts. We all know that high humidity helps to prevent shriveling. Yet high relative humidity causes root growth of onions.

In conclusion remember fruits and vegetables continue to live after harvest, but also continue to age and deteriorate. Proper use of refrigeration and postharvest treatments can minimize this aging and deterioration and help supply high quality produce for the consumer.

Table 1 Fruits and vegetables subject to chilling injury and proper storage temperature 1/

Fresh Fruits

Commodity	Storage temp.(° F)	Commodity	Storage temp(° F)
Avocados	45-55	Mangoes	55
Grapefruit	50-60	Olives	45-50
Lemons	50-58	Papayas	45
Limes	48-50	Pineapples	
		Mature green	50-55
		Ripe	45

Fresh Vegetables

Commodity	Storage temp.(° F)	Commodity	Storage temp(° F)
Beans - Green Snap	40-45	Sweet peppers	45-50
Cucumbers	45-50	Potatoes Early Crop	50-55
		Late Crop	38-50
Eggplant	45-50	Winter squash	45-55
Melons	45-50	Sweet potatoes	55-60
Okra	45-50	Tomatoes-Mature green	55-70
			45-50

1/ Other fruits and vegetables should be stored at 32° F or only a degree or two higher. All except onions should be stored at high relative humidity. Length of the storage life depends on the commodity.

Questions and Answer Session

Armour Armstrong
MarAd

Gentlemen, would anybody care to comment on any aspect of refrigerated containers and their problems?

Howard Baron
Seald Sweet Growers Inc.

I want to stress the importance of humidity control during the transport of perishables. What steps are being taken to maintain proper interior conditioning?

Mr. Armstrong

We certainly have the problem of humidity control, and there are a lot of people that have been working on it. Eric Rath wishes to say something.

Eric Rath
Cool-Chain Inc.

Howard Baron is correct in questioning the humidity control of perishables in transport. The first containerized shipment of Florida citrus was carried by United States Lines. It arrived in Switzerland after seventeen days in transit without even one percent of loss, due in part to proper humidity control. The main issue in the refrigeration of perishables in a container is the air pressure under which you operate. If you get the air to the product, then you don't have to do as much cycling of your refrigeration. Everytime you cycle the refrigeration, you remove the moisture from the container. For example, when Fruit Growers Express and the USDA tested trailers loaded with forty thousand pounds of citrus at Fruit Growers Express in Orlando, Florida, they took as much as 85 gallons of liquid out of the container in the first 48 hours. That is where the moisture goes. Every cycle takes the moisture out instead of preserving the conditioned air.

Mr. Armstrong

Thank you Eric.

Dale Anderson
USDA

Wilson Smith mentioned something about sanitation, I believe that we are going to be faced with several levels of sanitation control, possibly even microbiological controls, because of our own regulatory agencies and those in foreign countries. The recent meetings that I have attended indicate that this will

be a serious issue. We will have to consider it for fruits and vegetables, but primarily for meat products, and I am not sure that we have containers that are geared up to this type of sanitation control both in cleaning the container before we put the shipment in and in terms of maintaining the microbiological levels that may be required. We're going to have to give some serious thought to this area.

Mr. Armstrong

Is there anyone with something to contribute on sanitation?

George Raeder
Fruehauf Corp.

I would like to ask a question of the gentlemen up here whether or not the arsenic treatment in plywood is satisfactory for the certification of containers.

Charles Amyx
USDA

It so happens that when the Australians came up with this requirement that all wood shall be treated and they gave us a list of 20 acceptable arsenic compounds. We informed some of the container manufacturers at that time and they called us immediately. We tried to get the Australians off this approach, but we couldn't. We asked the Australian government if they would allow a substitute for the arsenic treatment and asked our own Food and Drug Administration if they would approve plastic coated wood flooring and linings so that the treated wood would not touch food. Neither would accept changes. Actually the problem is not within the scope of my work in plant quarantine; we found that we couldn't do anything with it. Then our agricultural attaché and U.S. commercial counselor in Australia tried to do something, but were not able to get the Australians off their tack. They have a fear of wood infested with the eastern carpenter ant. Maybe some of you have been stuck having to fumigate an entire ship's hold because of this problem.

It seems that you will have to go back to the Food and Drug and see if they will do something about approving plasticized wood or some other barrier to hold in the arsenic. Many knowledgeable individuals have concluded that the Food and Drug Administration's position on this matter was over-cautious.

We have some correspondence and we will be glad to give it to you. We were unable to lick the problem because it was out of our area of responsibility.

Mr. Raeder

This process has been used for 8-10 years on plywood lining for containers and trailers, with no contamination problems coming into the states. But now, all of the sudden, it has come up and we want to know definitely whether we can use it or we can't.

Clark Abbott
Fruehauf Corp.

Let's not put it on Australia. It's our own problem with arsenic in the United States.

Mr. Amyx

You will have to go back to the Food and Drug Administration.

Mr. Armstrong

It appears that this problem is the same one that was raised sometime back by Farrell Lines. (Mr. Letteney of Farrell Lines sitting in the audience concurred). The problem seems to keep recurring and we ought to get it cleared up once and for all.

Vincent Grey
MarAd

Going back to the question that was raised on sanitation. Within the ISO Committee, the same question came up as to what should be the sanitary aspects of a refrigerated container for standardization purposes. These would be inserted into the specification. The other countries participating in the program felt that the interior should be painted white, that the surfaces should be smooth and capable of being cleaned, and that there should be no pockets available for bacteria to grow. Such requirements seem reasonable until you try to establish a simple and practical method of test by which a person can determine by some pass/fail criterion whether a container has met these requirements. We, in the U.S. Delegation to the ISO meetings, were at least successful in having them drop the matter until we can come up with an appropriate way to measure sanitary qualities of a freight container. Within the MH 5 committee, the National Standards Committee, we would welcome any suggestions as to how, this aspect of a reefer container specification could be treated. Whether you could use some kind of roughness gauge for the interior surfaces appears questionable but these ideas have been speculated about. However nothing has been established or finalized as yet.

Thomas Poerstel
USDA

Mr. Cook and Mr. Hartman both spoke this morning about the availability of containers. They used pretty good figures on what we need in order to move refrigerated products overseas. Mr. Cook mentioned one subject which is a real bug to us and that is the coordination of these movements -- the need for adequate containers to be in the right places at the right time. I have done a survey of the American carriers as to what's available for our needs. My question to the American carriers is what type of priority do you place on making available to the agricultural community the number of refrigerated containers that will be required in the years to come as we continue to increase our export program.

James Clark
Sea-Land

As the agricultural markets develop, naturally, we as carriers are looking to pick up the business. Sometimes it seems like we are too late with too little, but it is not necessarily a matter of containers in all cases or the availability of containers. A lot of times you get into an area where the actual capacity of the vessels is not sufficient for the market and I think we are in that kind of situation in several areas right now. But we are working on it. We are working on other means of being able to load containers in other places on the vessel and so forth. I hope that answers your question.

Mr. Poerstel

Certainly, Jim, we're well aware of the work Sea-Land has been doing and we know that the other American carriers are working on this too. We are beginning to develop around the country a greater interest in exports. Agriculture is finding people that at one time didn't even like the word "export"; there was no committment on their part. Now they are starting to show some interest but what we don't want to happen is that just when they are ready to begin exporting, all of a sudden they have a problem which is a comparatively serious one.

Also we hear the statements like, "I ordered 14 containers and all I got was 2 containers." I know we need a lot of help, and the shippers are willing to work with the carriers.

I still ask the question of the carriers in general, "What is the priority on acquiring refrigerated containers?" I know there are plenty of dry cargo type vans around and I know you don't want to bring these (refrigerated) containers inland for good reason.

Mr. Armstrong

Carriers are always interested in high revenue freight, and when we talk about refrigerated perishables we are into high revenue freight classifications so I think a high priority is here. It does take some kind of coordination to use them to best advantage. As we have shipper advisory boards in the railroad field which help shippers know seasonal demands and location demands, it is possible that we need a similar arrangement for the marine carrier of refrigerated containers. I guess, Tom, here is where we have to do some more work on the Government side that will help corral the types of demands and the fluctuations in demands for specialized containers so that the carriers can know the kind of equipment that would be available to them. Certainly they are looking for the business.

Mr. Abbott

I don't think it is the carrier who is the sole culprit; it's probably the container and trailer industry too. They are having a record breaking production year and, for the most part, every manufacturer is loaded with orders right thru the end of this year. In other words, even though the carrier has ordered the equipment, its another matter to be able to deliver it.

Eugene Hindin
Gindy

I think that maybe the problem with refrigerated containers is that old devil "economics" again. We hear about high tariff rates on perishables, but I'm afraid that when most of the carriers look at the cost of refrigerated containers and what the rates are and the degree of utilization that they get out of them and when they are going to get them back from inland and when and who's going to pay for the deadhaul of containers, it's not really as high rated a commodity as it first appears. I think in this one area I have a little bit of sympathy with the shippers, steamship companies and everybody who wants the containers. It's just hard to get enough utilization out of them to make the economics work out at the present rates.

Mr. Armstrong

Very valid!

Peter Nelsen
Globus Corp.

We have developed a refrigerated container for the aircraft industry and we have been looking for an over-the-road container that we can transport to New York. A refrigerated container is 88 inches wide inside and a standard aircraft pallet is 88 inches outside. In the interest of intermodal requirements it would be good if one could fit inside the other and be capable of being transported.

Mr. Grey

In this national standards committee on containers that I mentioned, MH 5, we have had basically four groups serving the aircraft industry: the airframe manufacturers, the air transport operators, the Air Force logistics command and the air freight forwarders. Now with this type of representation we certainly feel that the air industry as a whole had an ample voice in arriving at the standard dimensions of containers. But when we get into this problem of what should be the internal width of a refrigerated container and we must work backwards from the 96 inch overall width of all containers, we are immediately faced with the problem of the thickness of the walls. Common wall thickness for low-temperature service is 4 inches — this factor alone dictates an 88 inch internal width. There was no oversight with respect to aircraft pallet compatibility. Sometimes if you serve one industry, you're hurting another one.

There is another ANSI committee identified as MH 10 that's working on the unit load standardization aspects. This factor of 88 adopted by committee MH 5 now permits MH 10 to develop a modular family of unit load sizes that can be accommodated in a <u>reefer</u> container. They have completed their work with respect to the dry vans, but not with reefers, so this MH 5 work now at least opens the path in that direction.

Captain Allen
Marine Container Equip.

I was thinking about one of the reasons why we have operational difficulties today and its connected with standards also. It deals with the temperature markings on thermometers, recorders and thermostats. When someone says 32^{o} chances are they mean in our own Farenheit system. But this is also 0 degrees Centigrade and sometimes they have been reversed and as a result we had damaged cargo. I think maybe we should move more towards accepting the international metric system or at least indicating on our own reefer units

to a greater degree which measurement system applies, particularly on the older units.

Robert Olt
Union Carbide

On a standard rating system for containers would it be dependent or independent of the type of refrigeration system used?

Mr. Grey

It would be independent of the reefer unit. The rating can be made with or without the unit in place but the rating plate would have to state whether or not the reefer unit was in place for the rating. If it was in place during the rating, then the model number or capacity of the unit would have to be shown. This would convey to anybody using the container what the conditions of test were for rating. But it is absolutely independent of any of the specific types of refrigerant.

Mr. Chairman, I would like to raise a subject for possible discussion — the cost of maintenance of reefer units. A 40-foot reefer unit may cost in the area of $12,000 which would include $3,000 for the nose unit. And yet from information that comes to us from carriers, the annual maintenance cost for these can be as high as $2,000 a year or something just short of that. The subject bears somewhat on questions that came up earlier about the availability of containers. If these containers are in the maintenance shops all the time, certainly the question of availability will be affected. Most likely such a high maintenance cost would indicate a significant amount of down time. In questioning the carriers, why was the cost so high, one of the problems that came up was the lack of trained maintenance personnel — and here they were talking about domestic shops only. When you talk about what it amounts to in maintenance shops abroad, it's even worse. I wonder if the carriers present or the reefer unit manufacturers can comment along the idea of approaching design from a standpoint of reduction of the down time?

Mr. Rath

I appreciate the question very much because I have been preaching for the last 10 or 12 years that the ocean-going refrigerated unit has to be a dual unit. It is a silly idea that somebody is going to change a unit on board of a ship going across the Pacific or the North Atlantic. So I think a safe refrigerated

unit that will deliver products under any circumstances should be a dual unit. This means it should have two independent systems built into the same container that you can operate at all times. Now this isn't as much of a problem as it appears. I appreciate receiving the figure of $2,000 for maintenance because on a dual unit our maintenance figure is approximately $200 a unit per year so that we have a difference of $1,800 a unit per year to our advantage. The sea is merciless and if you don't have equipment that is designed for sea service or adaptable to sea service you always will have those kinds of overall costs. If you are going to talk about "life cycle" costs, this dual system approach provides a better unit and a lower total cost.

Malchoff Davis
Carrier Transicold

I would just like to say that redundancy is an excellent idea but in many cases, redundancy incurs its own problems. There are materials and instruments and compressors available however, that will give people the reliability that they want. But it's rather difficult to define "reliability". Is a unit reliable when it comes from the manufacturer? It may be reliable at that time but then is it reliable after someone has worked on it? I don't know the answers. I do know that in many cases we as equipment manufacturers feel that the feedback of information from the users is not complete enough for us to define whether we have a reliability problem or whether the carrier may have a maintenance problem. I'm sure that we can design the reliability where needed, but people that use the equipment must have maintenance records that manufacturers can determine whether there is some sort of individual maintenance problem or whether it is design-oriented.

Captain Allen

It is a question of priorities and whether the carriers have time to analyze maintenance problems and convert the information into corrective action. Most carriers do not have the ability to provide R & D services in the purchase of containers and depend on some agency to act as an intermediary between the manufacturer and themselves in the purchase of such equipment. This practice seemed to be growing because it fills a necessary service. My own company has served in such capacity and its expanding every year.

Mr. Armstrong

The time for questions and answers appears to have expired so we will now move into the final wrap-up.

SUMMARY REMARKS

Robert F. Guilfoy, Jr.
Transportation and Packaging Research Lab.
Agricultural Research Service, USDA

In this summary I will comment on certain points made by speakers, list some of the basic requirements for a successful export program, and suggest a possible course of action.

Comments of speakers

In his talk, Mr. Clark suggested that more effort be directed toward improving containers already in service, rather than trying to design new types of containers. There is certainly merit to this suggestion for the reasons cited by Mr. Clark. I will relay his thoughts on this matter to the research group in the USDA which is doing research in this area.

Mr. Mayrsohn would like to be able to have USDA inspection of fresh fruits and vegetables at the inland points where the containers are loaded, rather than having to reopen containers for inspection at the port as with the present inspection system. I have checked this point with the Plant Protection and Quarantine people of the USDA, and am advised that they are continuing to look for solutions to the problem of inspecting export produce at point of loading.

Requirements for export

If we assume that tariffs and other trade barriers will be removed, the successful movement and delivery of perishable products to overseas receivers will depend upon three elements. These elements are the product shipped, the container, and the transport operation.

The U.S. product must be of top quality, precooled to the right temperature, adequately packaged, and loaded into the container so as to prevent physical damage enroute.

Refrigerated containers must be of the best design available, properly maintained, and capable of holding the product temperature within a close tolerance.

The transport operation from the shipping point to the final overseas receiver must be done in as short a time as possible because of the perishability of fresh products. Furthermore, the overseas receiver must be able to count on regular deliveries.

Suggested course of action

If we are to increase our exports of fresh products we will have to, as Mr. Cook points out, have a team effort. This suggests the need for a task force, possibly made up of growers, shippers, carriers, receivers, market promoters, and others as determined necessary.

At first, such a task force would probably be better off to concentrate on one potentially high volume item, such as lettuce. Mr. Cook indicates a possible market for lettuce in Europe of 5,000 container loads per year, or about 100 loads per week. Such a volume would allow the railroads to think in terms of unit trains, which is one of the keys to a successful export operation.

Conclusion

The members of the planning staff at the Commerce Department are to be commended for developing and sponsoring this conference. It is timely and a service to the public and the industries concerned.